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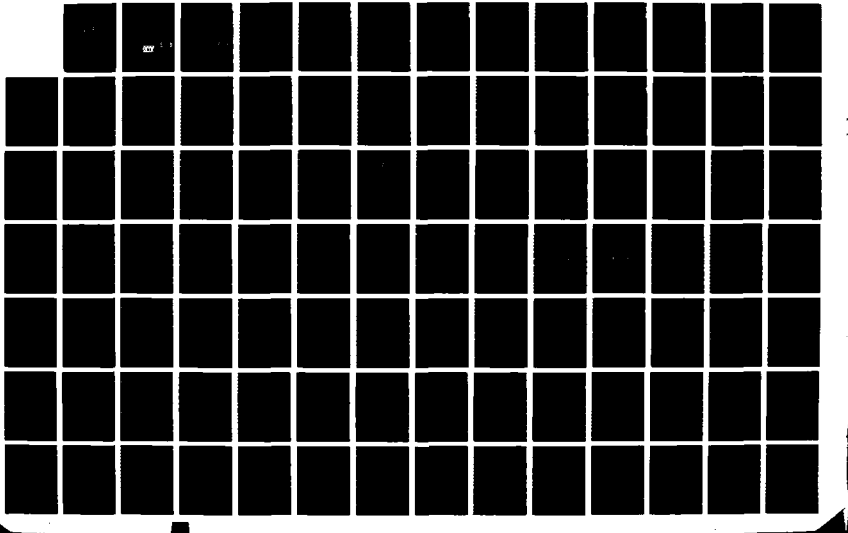

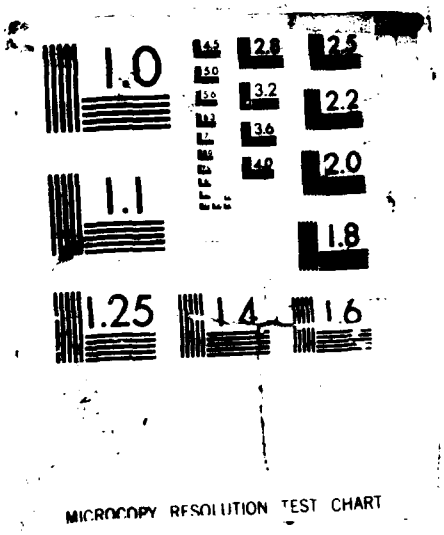

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FINAL REPORT

SURVEY STATE OF THE ART: ELECTRICAL LOAD MANAGEMENT TECHNIQUES AND EQUIPMENT

DAAK70-86-C-0035

enviro-management & research, inc.

(2)

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SURVEY STATE OF THE ART:

ELECTRICAL LOAD MANAGEMENT

TECHNIQUES AND EQUIPMENT

DAAK70-86-C-0035

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Tactical military systems rely extensively on electric power in the field. Generating capacity requirements can be minimized by relying on state-of-the-art load management techniques. This report provides an overview of the techniques used, and indicates that smaller energy management systems (EMS) in particular may be applicable to tactical military systems. The report identifies load management techniques and equipment whose application will: 1) reduce the extent of generation equipment needed by tactical systems; 2) improve equipment utilization, reducing fuel consumption and operating cost, 3) improve system reliability/availability, and 4) permit better management of equipment operation and resources in meeting mission goals. Appendix A contains a detailed discussion of remote control systems used for load management, Appendix B contains a listing of selected EMS manufacturers, and Appendix C contains descriptive literature on selected energy management systems.

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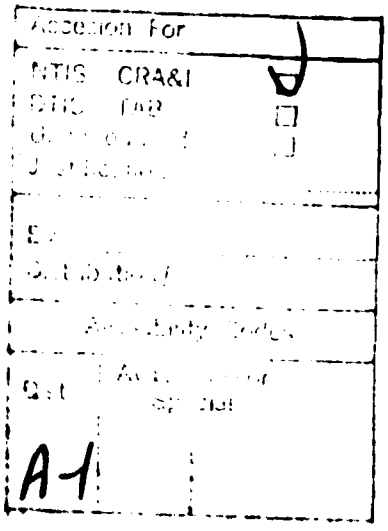
The citation of trade names and names of manufacturers in this report is not to be construed as official Government endorsement or approval of commercial products or services referenced herein.



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EXECUTIVE SUMMARY

The modern Army depends on electricity to meet the needs of its tactical military systems. The extent of the generating equipment needed to furnish electricity in the field is a critical concern. Generating capacity requirements can be minimized by applying state-of-the-art load management techniques. This report provides an overview of the techniques used, and points out that smaller energy management systems (EMS) in particular may be applicable to tactical military systems. Such systems can turn off noncritical equipment and cycle a large number of electric loads on and off so that a significant percentage of loads are off at times of system peak demand. Other load management strategies involve voltage reduction by utilities on a short-term basis, customer-owned battery storage systems, and remote control systems.

Energy management systems usually consist of controllers, data transmission links, field panels, modems, remote sensors, and remote actuators. However, not all components are required for an EMS to operate. The controller houses the CPU, memory, input/output system and the power supply. Software is also needed to program controller's functions.

Many different applications exist for energy management systems, with their ability to control conditions such as shelter temperature and humidity, system pressure, voltage, watts, amperes, kWh, power factors, electric loads, air flow and other process variables. Equipment and systems controlled by EMS may include air conditioners, ventilation blowers, space heaters, lighting, water heaters, equipment heaters, compressors, autoclaves, X-Ray systems, lens fabrication machines, cooking equipment, laundry equipment, maintenance equipment, communication equipment, computers, lighting, and electro-hydraulic/pneumatic systems.

The selection and acquisition of EMS requires consideration of several user concerns. Users must clearly define the specific mission objective, critical and noncritical loads, equipment characteristics, schedules, operator effectiveness, comfort and process concerns, reliability and flexibility considerations and training needs.

Additional user input is necessary to define specific applications and user considerations more precisely, to assure that load management can be effected without detracting from the military's ability to fulfill its mission. Information that documents applications and user needs is required to identify the type of energy management systems best suited to the user's mission. A detailed feasibility analysis, with associated cost/benefits of EMS application to various tactical systems also is needed. Design details and specifications must also be

developed, and field demonstration of EMS should then be undertaken. Operators manuals that describe system operating and maintenance procedures are also required.

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Section 1.0
INTRODUCTION

1.1 BACKGROUND

Tactical military systems rely extensively on electric power in the field. The capacity of the electrical generating equipment needed to furnish this power is determined by peak demand, that is, the maximum rate at which electric power is used. Systems must be sized to meet the maximum demand likely to be required, even though that maximum demand may be needed only on an occasional basis. Failure to accommodate maximum demand can result in mission delay or failure. While it is vital to meet maximum electrical demand, it also is important to minimize the amount of generating equipment that must be carried in the field.

The universe of applicable electric energy and demand management devices is broad and diverse, stimulated by two parallel developments.

The first development was the 1973-74 OPEC nations' petroleum embargo imposed on the United States, and, more particularly, the rapid energy price escalation that followed. Prior to that time virtually all forms of energy were inexpensive; so inexpensive that the value of saving energy was not sufficient to justify the

investment necessary to affect savings. Higher energy prices made conservation financially rewarding, and thus created a market for energy-saving equipment. Similarly, demand-management technology has been stimulated by the higher demand charges imposed by electric utilities, to encourage more discriminate power use and thereby forestall the need to add costly new generating capacity.

The other development comprises rapid technological progress in the field of microelectronics. Over a 10-year span, this technology has become smaller, more powerful, more reliable and less expensive, and today is being used in buildings, automobiles and even appliances. Applications in the area of demand and energy management have been multifaceted, given the needs involved and rapid paybacks available.

Electric load management devices can be applied to enhance the military's ability to fulfill its mission in a cost-effective manner. Such devices can help reduce the amount and size of generation equipment required, while at the same time improving equipment utilization and reducing fuel consumption and operating costs. However, most of the applicable devices will require "ruggedization" to meet the needs of tactical systems.

1.2 PROJECT OBJECTIVE

The primary objective of this project was to identify load management techniques and equipment whose application will:

1) reduce the extent of generation equipment needed by tactical systems; 2) improve equipment utilization, reducing fuel consumption and operating cost, 3) improve system reliability/availability, and 4) permit better management of equipment operation and resources in meeting mission goals. In this regard it was necessary to inventory existing and developing technologies, equipment and techniques, and then identify those which are most suited for military tactical systems applications. Future development needed to exploit the full potential of such technologies for tactical military systems was also defined.

1.3 RESEARCH METHODOLOGY

As an initial step, Enviro-Management & Research, Inc., (E-M&R) undertook a comprehensive review of existing literature which identified load management techniques, methodologies, equipment, standards, testing procedures and manufacturers. Contacts were made with several organizations including: Electric Power Research Institute, Edison Electric Institute, National Electrical Manufacturers Association, National Electrical Contractors Association, Institute of Electrical and Electronics Engineers, American National Standards Institute, American Society of Heating, Refrigerating and Air Conditioning Engineers, Inc., Association of Energy Engineers, Underwriters Laboratories, Inc., National Bureau of Standards, U.S. Department of Energy and its various laboratories to obtain reports relating to electrical load management and also obtain information on planned research and development.

A comprehensive survey of manufacturers was undertaken to obtain data and descriptive literature on current and planned electric load management systems and techniques. Specifically the data obtained on microprocessor-based EMS included:

- Model number,
- Type of controller (single-function, multi-function, etc.),
- Programming (relay ladder, microprocessor-based),
- Number of inputs/outputs
- Functions that can be performed (demand control, programmed on/off)
- Equipment size, weight, ruggedness
- Operating characteristics
- Electrical characteristics
- Environmental criteria
- Equipment availability
- Program and data memory capability
- Factory tests
- UL listing
- Reliability data (MTBF)
- Cost (general ranges), and
- Ongoing research and development.

All data collected was analyzed in light of basic tactical military systems load management objectives.

The data was also analyzed to determine the extent to which current and planned EMS equipment can meet the tactical system performance requirements of military equipment and the EMS capability for militarization.

Section 2.0

ELECTRIC LOAD MANAGEMENT TECHNIQUES AND EQUIPMENT

The concept of electric demand or load management was developed just after the birth of the electric utility industry. However, it was not until the early 1970s that the concept was applied on a widespread basis. Utilities generally apply load control in order to bring average demand as close as possible to maximum demand, to derive maximum use from available capacity, and thus a maximum return on the investment.

Customers are anxious to effect demand management because utilities impose a separate charge for demand, and this amount can be substantial.

The principal strategy that is being used by most utilities involves turning off unneeded equipment and cycling a large number of electric energy users on and off so that a significant percentage of energy users are off at times of system peak demand. Automated control systems which can accomplish these peak demand control strategies are currently in widespread use. Such systems can generally be categorized as remote control systems or local control systems.

Remote control systems affect load control utilizing a remote communication system. The parameters of control (when, what and how to control) are determined by the utility. The hardware on customer premises consists simply of a communication receiver, signal decoder, and switch for opening or closing the load circuit.

Local control systems involve the use of customer-owned and operated control devices to reduce electrical demand.

Other alternatives involve the use of voltage reduction, applied by utilities on a short-term basis and customer-owned battery storage systems.

A brief description of voltage reduction strategy and battery storage systems is provided below. It should be noted that many of the control systems described do not directly apply to military tactical system needs, but are described here to provide a better understanding of currently available load control systems.

2.1 VOLTAGE REDUCTION

Utilities use this strategy only under emergency conditions. Generally, voltage is reduced only when abnormal operating conditions within a total system cause a seriously low level of generating reserve. These conditions include multiple outages of generating capacity, limitations of transmission capability, and

higher than anticipated demand due to weather sensitive loads. Generally, voltage levels are reduced 3 to 5 percent, but in some cases an 8 percent reduction is utilized. The load-limiting effect of voltage reduction is difficult to determine. During summer months, load reductions from 1.2 to 1 percent have been reported to have been obtained from each percent of voltage reductions.

2.2 BATTERY STORAGE SYSTEMS

Another potential load limiting strategy involves the use of battery storage technology, which has been the subject of extensive research and development, particularly for use with electrically-powered vehicles. It is now being considered for demand control in buildings. Any demand beyond a predetermined maximum is met through the battery storage system (Figure 2-1). The system is recharged during off-peak times.

Most battery storage systems have six cells and a normal voltage of 12 volts. The power and storage capacity of the batteries tend to vary with discharge rate, e.g., 300 watts for a 3-hour discharge to about 210 watts for an 8-hour discharge. Storage capacity varies from about 945 watt-hours over a 3-hour discharge to about 1050 watt-hours for an 8-hour discharge. Systems whose capacity is 10 kW or less are available as uninterruptible power supply packages or as modular battery storage systems consisting of the batteries, a charger, an inverter, and other necessary switching and power conditioning components. These

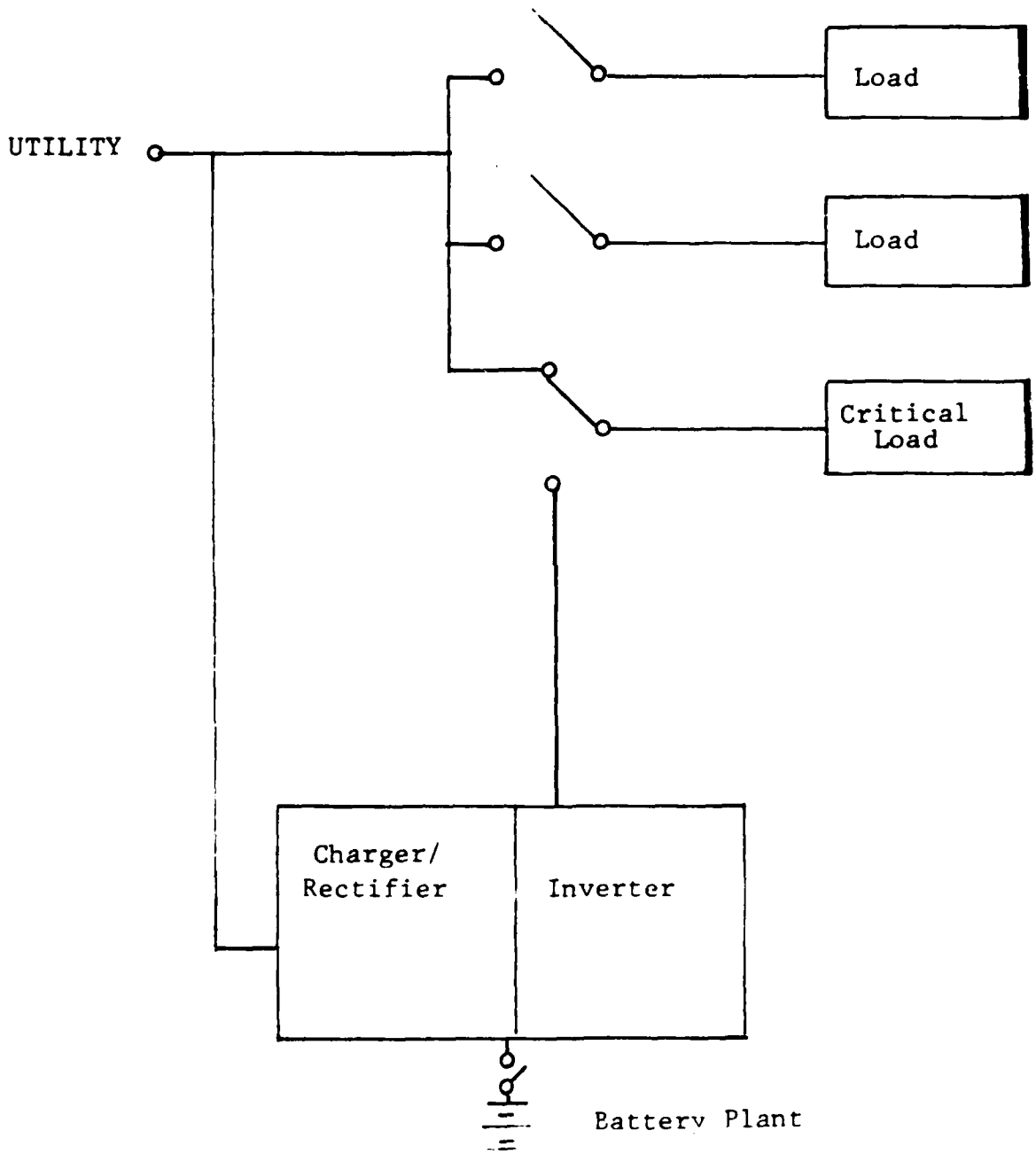


Figure 2-1. Basic Components of a Battery Storage Demand Management System

systems occupy about 2-5 ft^3/kW.

2.3 REMOTE CONTROL SYSTEMS

All remote control systems consist essentially of three major components: a central controller, the communication system, and receiver switches. Several communication systems exist: radio frequency systems (VHF-FM), ripple, powerline carrier, and a combination radio frequency/powerline carrier. Of all these communication systems, radio frequency systems are the most frequently used, due to features such as low cost, simplicity of operation, and proven high reliability. Further discussion on these communication systems is contained in Appendix A.

2.4 LOCAL CONTROL SYSTEMS

Local control systems involve the use of load-control devices that incorporate a switching function into some level of local, on-site logic. These devices include everything from mechanically programmable time switches to sophisticated microprocessor-based energy management systems. All local controllers are designed to limit or defer loads in a particular location. They differ, however, in the method or level of load control exercised.

Local controllers also differ in the manner in which each device is activated. The method of activation is important because it

determines when -- rather than how -- control will be exercised. Local controllers can be categorized according to their method of activation: site-specific activation, time-specific activation, and temperature-specific activation.

Site-specific activation controllers are designed to limit the peak demand of a facility regardless of coincidence with the utility's peak. Time-specific activation refers to those local controllers that perform their designed load deferral or load-limiting functions only during certain times of the day. Temperature-specific activation refers to those local controllers that perform load cycling or deferral only when outdoor ambient temperatures meet or exceed preset levels. Temperature-specific controllers sometimes also operate in conjunction with time-specific activation.

Four different types of local control devices are presently being used.

2.4.1 Priority Relay/Appliance Interlock

One of the simplest forms of local control is the priority relay. A priority relay, or "interlock" as it is often called, is a device designed to limit the maximum demand in any given application by preventing two or more high-load appliances from being used at the same time. The device monitors the current draw on a priority, or non-interruptible, load by means of a current transformer or other type of sensing device. When the

priority load is turned on or when the current draw of the priority load exceeds a preset maximum, the device cuts off power to an interruptible load. When the priority load is turned off, the device restores power to the interruptible load. This action effectively prevents both loads from coming on at the same time. As such, this theoretically decreases the maximum potential non-coincident system demand by a value equal to the smaller of the two connected loads.

2.4.2 Load Management Thermostats

Load management thermostats are thermostats that automatically alter the temperature settings at a location in a manner that best serves the needs of the utility's load pattern. These devices operate on the same general principle of load management as remote cyclic control of air conditioners and/or heating systems. The major difference is that load management thermostats control the duty cycle of a heating or cooling system indirectly by controlling the temperature settings rather than by directly controlling the appliance's maximum on-time.

2.4.3 Energy Management Systems

Energy Management Systems (EMS) are the most flexible local controllers. These devices monitor electricity use, and when demands are about to exceed a specified level, the EMS sheds some loads. The control logic -- often microprocessor based -- turns appliances off according to the priority set by the customer. The load shedding may be rotated between equipment and appliances

every few seconds (for resistance heating loads) or it may disrupt service to selected equipment and appliances for periods of several minutes depending on the customer's priorities and needs. Because the user can change demand levels and priorities, EMS are very flexible in their use.

The most common application of EMS to date has been in commercial and industrial buildings. In this application most EMS normally perform numerous functions as shown in Table 2-1. EMS hardware configurations can range from small microprocessor-based systems to large centralized multi-minicomputer systems. Among the newest EMS technologies are those known as fully distributed systems, in which the high reliability of local dedicated controllers is combined with the capability for sharing information among all of the controllers via a local network. EMS devices are by far the most applicable to the tactical military systems, and are discussed in more detail in Section 3.

2.4.4 Time and Temperature Cycler

A time and temperature switch is a relatively simple device designed primarily for the control of air conditioning systems. This device contains a thermostat that senses outdoor air temperature and an adjustable percentage timer. When the outdoor temperature reaches the device's preset activation temperature, the percentage timer acts to regulate the duty cycle of the air conditioner. This timer is typically set for 50% duty cycles on a half-hour basis (15 minutes on, 15 minutes off). Control

TABLE 2-1

FUNCTIONAL CAPABILITIES OF ENERGY MANAGEMENT SYSTEMS

Function	Terminology
Turn off equipment when building is unoccupied according to a set schedule.	Start/stop control
Restart equipment at the latest possible time before reoccupancy.	Optimal start/stop
Change temperature set points of thermostats during unoccupied periods.	Temperature setback/ setup
Use "free cooling" from outdoors when outdoor air temp. is suitable.	Economizer control
Reduce excessive heating and cooling in HVAC systems.	Supply temperature reset
Reduce peak electrical demands.	Electrical Demand Control
Turn off equipment a percentage of the time according to an established schedule to reduce energy use and/or demand.	Duty cycling
Logging conditions, equipment run time, energy use, etc.	Monitoring/alarm

continues until the outdoor temperature falls below a preset

deactivation temperature.

Section 3.0

ENERGY MANAGEMENT SYSTEMS

Energy management systems (EMS) are being widely used in buildings to control demand and minimize energy use. They can automatically turn equipment on and off based on user needs, minimize the amount of equipment required to meet the user's needs and shut down selected equipment on a priority basis for short periods of time. Many EMS devices can be adapted for use with military tactical systems. However, the equipment used must be rugged, compact in size and transportable. Equipment meeting ruggedness criteria as defined by the Army must be capable of withstanding various tests, including vibration and shock tests.

Although traditional control manufacturers still dominate the EMS industry, there have been innumerable newcomers to the field, primarily companies which are more oriented toward microelectronics than controls. This has resulted in aggressive competition, introduction of continually more advanced and more specialized equipment and declining prices.

The result of these developments is that some type of EMS is almost guaranteed to be of value in almost any application.

During the course of this study, contacts were made with several EMS manufacturers (see Appendix B). Data was obtained from all those that manufactured small energy management systems. This data is summarized in Table 3-1, and described in detail in Appendix C. Discussions with the manufacturers indicate that their equipment, to date, has primarily been applied in buildings, even though it can be used in field applications such as those involved with tactical military systems. The EMS equipment currently available has not been militarized. However, some manufacturers indicated the control unit is typically enclosed in a NEMA-approved metal enclosure and all the components in the cabinet are securely fastened. As such, in many instances equipment can be easily modified to meet the ruggedness test as specified by the Army.

3.1 TYPICAL EMS FUNCTIONS

Energy Management Systems (EMS) can perform numerous functions. Some of those that may apply to tactical systems are discussed below.

3.1.1 Automatic Start/Stop

Automatic Start/Stop function involves turning certain systems (air conditioning, electric heaters, etc.) and devices on and off at certain times as programmed by the end user. Some EMS can also perform Start/Stop optimization, especially as it relates to air conditioning and heating equipment, by monitoring outdoor air temperature, solar effects, indoor temperature and humidity

Table 3-1. Energy Management Systems Summary Matrix

Manufacturer	Basis of Logic	Inputs/ Outputs(1)	Electrical Characteristics	Environmental Criteria		Physical Characteristics				Functions Performed						Cost(2)	Reliability		Ruggedness
	Vendor Software		Supply Voltage, ac	Operating Temp.	Relative Humidity	Width	Depth	Height	Weight	Start/Stop	Demand Control	Duty Cycling	Alarm Reporting	Monitoring/Logging	Other		MTBF Data Available	MTOF Data Available	Meets Criteria
AET Systems, Inc.																			
Model 816/32	X	8-16	115	0-120F	5-95%	20"	x 4"	x 18"	17 lbs.	X	X	X	X	X	X		No	No	No
Model 448	X	4-8	115	0-120F	5-95%	14"	x 4"	x 12"	18 lbs.	X	X	X	X	X	X		No	No	No
AMF Paragon Electric Co.																			
Model EC-128	X	8-12	24	32-122F	0-90%	9"	x 4"	x 14"	8 lbs.	X	X	X	X	X	X		No	No	No
Model EC-732	X	4-32	24	0-120F	0-90%	18"	x 4"	x 11"	15 lbs.	X	X	X	X	X	X		No	No	No
Advanced Micro Systems																			
Model Vanguard Rim	X	16-32	120	35-105F	0-95%	16"	x 7"	x 24"	15 lbs.	X	X	X	X	X	X		No	No	No
Allen Bradley																			
Model SLC-100	X	6-112	120	32-140F	5-95%	10"	x 5"	x 4"	4 lbs.	X	X	X	X	X	X		No	No	No
Model PLC-4	X	32	115	32-140F	5-95%	14"	x 5"	x 15"	3 lbs.	X	X	X	X	X	X		No	No	No
American Auto Matrix																			
Model MCU	X	16	115	32-158F	0-90%	17"	x 5"	x 15"	10 lbs.	X	X	X	X	X	X		No	No	No
Andover Controls Corp																			
Model ACNET LUC 8	X	8	115	40-120F	10-95%	17"	x 4"	x 15"		X	X	X	X	X	X		No	No	No
Model AC8	X	16-640	117	40-120F	10-95%	24"	x 6"	x 16"	49 lbs.	X	X	X	X	X	X		No	No	No
Barber-Colman Co.																			
Model RCU 2	X	12-28	115	32-158F	0-90%	21"	x 6"	x 21"	13 lbs.	X	X	X	X	X	X		No	No	No

Table 3-1. Energy Management Systems Summary Matrix

Manufacturer	Basis of Logic	Inputs/ Outputs(1)	Electrical Characteristics	Environmental Criteria		Physical Characteristics				Functions Performed						Cost (2)	Reliability		Ruggedness
	Vendor Software		Supply Voltage, ac	Operating Temp.	Relative Humidity	Width	Depth	Height	Weight	Start/stop	Demand Control	Duty Cycling	Alarm Reporting	Monitoring/Logging	Other		MTBF Data Available	MTOF Data Available	Meets Criteria
Butler Controls Div.																			
Model B8A	X	8	115	0-122F	0-90F	11"	x 4"	x 17"	14 lbs.	X	X	X	X	X	X		No	No	No
Model ZM100	X	8	115	0-122F	0-90%	11"	x 4"	x 17"	14 lbs.	X	X	X	X	X	X		No	No	No
Computer Controls Corp.																			
Model LCG-4	X	16	24	0-120F	0-90%	9"	x 5"	x 6"	12 lbs.	X	X	X	X	X	X		No	No	No
Controlled Energy Systems Co.																			
Model K1500	X	8	120	40-120F	0-95%	12"	x 6"	x 18"	30 lbs.	X	X	X	X	X	X		No	No	No
Enconi Systems, Inc.																			
Model 400	X	4	14	30-100F	10-90%	12"	x 4"	x 12"	18 lbs.	X	X	X	X	X	X	$950	No	No	No
Model 800	X	8	14	30-100F	10-90%	12"	x 4"	x 12"	18 lbs.	X	X	X	X	X	X	$1250	No	No	No
Model 1600	X	16	24	30-100F	10-90%	12"	x 4"	x 18"	21 lbs.	X	X	X	X	X	X	$1330	No	No	No
Model 3200	X	32	24	30-100F	10-90%	12"	x 4"	x 24"	30 lbs.	X	X	X	X	X	X	$1520	No	No	No
Enercon Data Corp.																			
Model 100	X	64	24	32-122F	0-90%	12"	x 6"	x 18"	15 lbs.	X	X	X	X	X	X		No	No	No
Energy Management Corp.																			
Model 230	X	16-32	120	0-100F	0-95%	24"	x 9"	x 17"	36 lbs.	X	X	X	X	X	X		No	No	No

Table 3-1. Energy Management Systems Summary Matrix

Manufacturer	Basis of Logic	Inputs/ Outputs (1)	Electrical Characteristics	Environmental Criteria		Physical Characteristics				Functions Performed						Cost(2)	Reliability		Ruggedness
	Vendor Software		Supply Voltage	Operating Temp.	Relative Humidity	Width	Depth	Height	Weight	Start/Stop	Demand Control	Duty Cycling	Alarm Reporting	Monitoring/Logging	Other		MTBF Data Available	MTOF Data Available	Meets Criteria
Honeywell, Inc. Model W7000	X	10-40	120	32-122F	0-95%	16" x 7" x 20"				X	X	X	X	X	X		No	No	No
IDEC Systems and Controls Corp. Model Mach 1	X	8-16	120	32-140F	5-95%	8" x 3" x 8"				X	X	X	X	X	X	$500	No	No	No
Klockner Moeller Corp. Model PS3	X	8	120	32-140F	5-95%	8" x 3" x 8"										$335	No	No	No
Mangaux Controls Model MX4000	X	12-48	120	32-140F	0-95%	16" x 5" x 34"				X	X	X	X	X	X		No	No	No
MCC Powers Model SCU 600	X	8-16	120	32-122F	0-95%	24" x 10" x 24"			40	X	X	X	X	X	X		No	No	No
MicroControl Systems, Inc. TempMiser II	X	16	120	32-122F	0-90%	16" x 4" x 24"				X	X	X	X	X	X		No	No	No
Micro Mizer, Inc. Model Remote Proc. Unit	X	16-64	120														No	No	No
Savenpy Energy Systems Model SC 212	X	16	115	32-120F	0-90%	12" x 4" x 8"					X			X			No	No	No

Table 3-1. Energy Management Systems Summary Matrix

Manufacturer	Basis of Logic	Inputs/ Outputs(1)	Electrical Characteristics	Environmental Criteria		Physical Characteristics				Functions Performed						Cost(2)	Reliability		Ruggedness
	Vendor Software		Supply Voltage, ac	Operating Temp.	Relative Humidity	Width	Depth	Height	Weight	Start/Stop	Demand Control	Duty Cycling	Alarm Reporting	Monitoring/Logging	Other		MTBF Data Available	MTOF Data Available	Meets Criteria
Seaboard Energy Systems, Inc. Model System 90	X	90	120	32-120F	0-90%	24" x	9" x	24"	25 lbs.	X	X	X	X	X	X	$8000	No	No	No
Solidyne Corp Model 4002-8002	X	4-8	120	32-120F		14" x	4" x	9"	9 lbs.	X	X	X	X	X	X	$8000	No	No	No
Sparton Technology Model 5441	X	21	115	20-120F	0-95%	11" x	4" x	11"	8 lbs.	X	X	X	X	X	X	$1450	No	No	No
Square D. Co. Model SY/MAX 100	X	20-40	120			7" x	7" x	14"									No	No	No
Synergetics International Model 2DC	X	16	120			8" x	4" x	5"			X					$ 700	No	No	No
Toshiba Houston Model EX 20	X	20	115														No	No	No
Trane Co. Model Tracer 10	X	4-16	115			14" x	5" x	14"		X	X	X	X	X	X	$2750	No	No	No
Triang Microsystems, Inc. Model MP128	X	16	115	32-150F	0-95%	15" x	4" x	18"	30 lbs.	X	X	X	X	X	X	$6950	No	No	No

(1) Most manufacturers offer expansion modules to accommodate greater point capacities.

(2) Cost data was provided by only a few manufacturers. Where provided, cost represents the cost of the controller only.

calculation and analysis of this data and determining when systems should be started and stopped.

3.1.2 Demand Control

Demand control -- also known as demand limiting, load limiting, load control, or load shedding -- is a technique used to monitor energy use and limit the peak demand (Figure 3-1) by automatically shutting down selected equipment, on a priority basis, for short periods of time. Demand limits are preprogrammed into the demand control software required for this function.

3.1.3 Duty Cycling

Duty cycling (Figure 3-2) is used to stop and start (cycle) electric motors that normally run continuously. A common application is control of the motors that operate the air conditioning equipment. A typical example would be to stop assigned electrical motors for 15 minutes out of each operating hour. The program would be interfaced with space time temperature sensors to override the cycling if pre-designated conditions were not maintained.

Although energy use and demand reduction can be achieved, this feature must be approached cautiously and only upon close examination of the equipment to be controlled. Manufacturers should be consulted on the application of duty cycle programs to

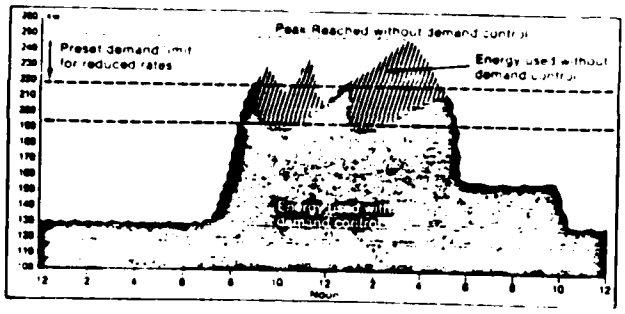


Figure 3-1. Demand Control

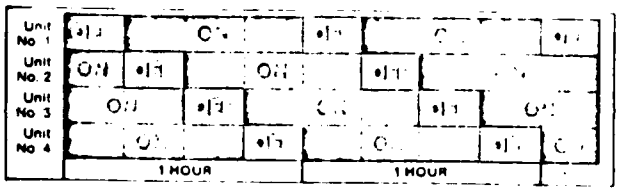


Figure 3-2. Typical Time Based Duty Cycling

their equipment, as frequent start/stop cycling may reduce the lifetime of a motor.

3.1.4 Monitoring Equipment/Alarms

Monitoring features are used to report and record trend, status, or alarm conditions. As a rule, all points on the system with analog and/or digital inputs and contact closures are continuously scanned. Alarm inputs that might be monitored

include indications of equipment malfunction, such as temperatures above or below the alarm limit setpoints of detector sensors, relative humidity above or below the setpoint, and security violations. Status monitoring verifies functional operation in terms of on/off, run/stop, fast/slow and open/close. Monitoring system performance can result in both operational and maintenance savings.

3.2 SYSTEM COMPONENTS

Energy management systems normally have several basic components as shown in Figure 3-3: controllers, data transmission links, field panels, modems, remote sensors, and remote activators. However, not all components are required to operate. Field panels and modems are not required with small EMS typically having point (each sensor or activator represents one control point) capabilities of less than 32.

3.2.1 Controllers

Controllers are general purpose microprocessor based control units that accept inputs, evaluate them and generate outputs to control machines or processes. The major components of a controller are the central processing unit (CPU), memory, input/output system, power supply and software.

3.2.1.1 CPU. The CPU is the "brain" of the controller and organizes all controller activity. The CPU receives input data, performs logical decisions based upon a stored program, and drives

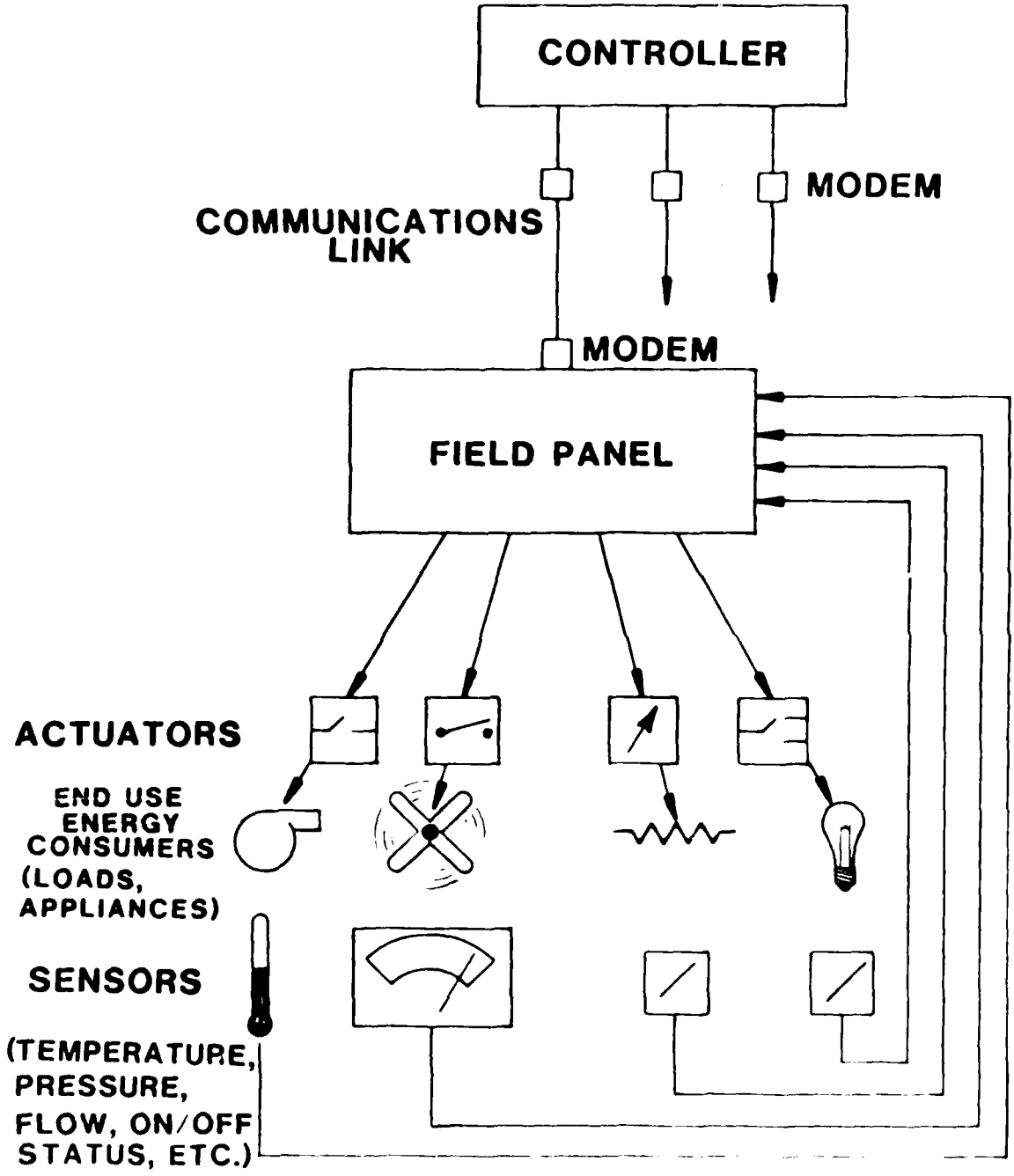


Figure 3-3. Major Components of a Programmable Controller

outputs. Normally, each controller has one CPU that can service or control many I/O points.

3.2.1.2 Memory system. The memory system provides a means of storing and retrieving data. The memory is divided into executive program and application program instructions. Executive program instructions that direct the CPU's activities are provided by the programmable controller (PC) manufacturer. The user enters the application program instructions that control machines or processes. The complexity of the control plan determines the amount of application program memory needed. The amount of memory required for an application is a function of program length, complexity of the user's requirement, and the number of I/O points involved. Memories are available in many forms and in specific increments ranging from 64 to 192K.

Currently, the most commonly used memory in controllers is a CMOSRAM (complementary metal oxide semiconductor random access memory). This is an integrated circuit-based memory that permits stored programs to be easily altered whenever necessary. Access is random, which means storage locations can be accessed in any order any number of times. No established sequence of accesses is required. The memory can be protected from power outages by lithium batteries having service lives as long as four years.

Programmable read only memory (PROM) is another popular semiconductor memory. PROM automatically retains its memory

during power failures, so battery backup power is not required. A shortcoming of PROM is that information cannot be easily erased once it is entered.

Programming devices (hand held programmers or CRTs) are usually required to enter the application programs into a PC's memory. Exceptions are very small single-board ROM PCs programmed by the manufacturer to do specific jobs.

3.2.1.3 Input/Output (I/O) System. The input/output (I/O) system has point capacities ranging from 8 to 4096. An I/O rack essentially consists of various groups of input circuit cards or modules mounted in a cabinet. Typically, I/O modules contain 4, 8, 16, or 32 circuits. The input cards receive data from field input devices such as limit switches, relay contacts, analog sensors, or selector switches. The cards accept the incoming control voltages acceptable to the CPU.

The CPU controls the output card signals that drive field output devices such as motor starters, solenoid valves, indicator lights, light emitting diode (LED) displays, positioning valves, or relay coils. The output cards transform the logic output voltages into levels required to drive the field output units.

Controllers may have digital modules, analog modules, or both. Digital input signals are typically supplied by pushbuttons, switches, contacts, or sensors. Analog input signals are

provided by such items as process instrumentations or transducers. Digital cards do not accept or generate analog signals. They handle only high level on-off signals in the range of 5V DC to 240V AC. A wide variety of I/O voltages, current capacities, and module types are available. PCs handle analog information in one of two ways. They compare the input signal against the preset level within an input module with the objective of developing an on/off limit signal; or they perform analog-to-digit (A/D) conversion, where the continuous input is transformed into digital code representing its numeric value.

3.2.1.4 Power Supplies. Power supplies provide all the voltage levels required for the PC's internal operations. The power supply can be packaged directly into the CPU or installed some distance away as a separate unit connected to the CPU by a cable. The power supply converts 120 or 220V AC line power into the DC power required by the CPU and I/O modules. For example, power supplies may convert 120V AC into 5 or 15V DC, or 220V AC into 24V DC.

3.2.1.5 Software. All microprocessor-based controllers require software to operate. Three types are normally used: executive software, command software and application software.

Executive software comprises the basic programs which cause the computer to function. It includes operating procedures for input/output devices and programs which load and unload command

and applications software. System software is also used to upgrade the operation of the EMS by refining existing programs, expanding them, or adding new ones.

Command software refers to that group of programs which permit the operator to communicate with the EMS to perform required actions, such as monitoring a control point or sending an instruction.

Application software is that set of programs which specify functions to occur, such as demand control or duty cycling.

In all cases, the small microprocessor-based EMS software is supplied by the manufacturer. The operator may select or adjust variable settings but cannot alter the programmed logic at this time. All program modifications must be made by the manufacturer.

3.2.2 Field Panels

Field panels provide an interface between the programmable controller and remote sensors and actuators. There are two basic types: field interface devices and multiplexors (MUX's).

Field interface devices (FID's) serve as a point of consolidation for many sensor and control points. Each sensor or actuator represents one control point. Uncoded signals from sensors are received, coded, and sent to the controller. Conversely, coded information is received from the controller, decoded, and sent

back to the actuators. The number of control points that can be accommodated varies from 4 to 200. "Intelligent" or "smart" FID's have their own controller to process information and respond with instructions.

Multiplexors minimize necessary data transmission media by using time-shared transmission, or multiplexing, to regulate the flow of signals over a single channel. Prior to transmission, the signals are coded to identify their origin. The MUX can also receive and route multiplexed signals to appropriate destinations. MUX panel capacity typically ranges up to 64 points. "Intelligent" multiplexors (IMUX's) transmit time-shared signals on a "report by exception mode," thereby eliminating repetitive information on steady-state conditions.

3.2.3 MODEM's

MODEM is an acronym for modulator/demodulator. MODEM's communicate between FID's, MUX's, and programmable controllers when the controller is separate from the field panel. Upon receiving a signal from a sensor or controller, the MODEM imposes the information in binary form onto carrier waves. These waves convey information over data transmission links. The information is imposed on the wave by altering, or modulating, the wave form; it is then extracted from the wave by demodulating. In the case of a digital signal from a sensor or binary codes from programmable controllers, this process is straightforward. Analog signals from sensors require

analog/digital converters to condition the signal prior to modulation.

The speed of data transmission is measured in bits per second, which are single binary digits, or in bauds. For EMS applications, one baud is one bit per second, and speeds of 300, 1200, 2400, 4800 and 9600 baud are used.

3.2.4 Data Transmission Link

A communications network is necessary to transport the control signals from the programmable controller's CPU to the individual loads being controlled. Two methods can be used for this purpose: parallel wiring from the CPU to each load, or multiplexing a group of signals from the CPU over common data transmission media to receiving stations conveniently located near groups of loads.

Parallel wiring requires routing two wires from the controller's CPU to each load, so the presence of large numbers of loads makes this method impractical. Multiplexing is usually the preferred method when large numbers of remotely located loads are involved such as in the case of field hospitals. The data transmission media (DTM) used with these larger systems can be one of the following types: twisted pairs; telephone lines; coaxial cable; power-line carrier systems; radio frequency signals; and/or fiber optics. However, in tactical system applications, only the

twisted pairs or the radio frequency signals are most practical.

Twisted pair DTM consists of any two low-voltage conductors which are insulated and twisted together to minimize interference by unwanted signals. Twisted pairs come in either 2- or 4-wire configurations to support either half-duplex (nonparallel transmission of signals) or full duplex (simultaneous transmission of signals independently in both directions) transmission.

For EMS applications lines are conditioned by adding protective shields to cover voice or higher-grade twisted pairs in an effort to minimize interference. If data transmission occurs at a rate of 1200 bits per second or less, unconditioned lines are usually used. For higher rates, specially selected and conditioned twisted pairs must be used.

3.2.5 Sensors

Sensors are remote input devices which are connected to the terminal block usually located in the FID. Sensors measure the condition of a variable such as temperature, relative humidity, pressure, flow, level, electrical units, and position of various mechanical devices. They also monitor relay, switch, or other binary devices. The signal from a sensor or other input device is either analog or binary.

An **analog** signal is a continuously variable signal which bears a known relationship to the value of the measured variable. As an example, a thermocouple measures temperature, and emits a signal in the form of a voltage; a resistance temperature device (RTD) measures temperature and emits a signal in the form of an electrical resistance. Such analog signals must be converted to digital form before a computer can use them.

A **binary** signal is an input signal equivalent to an electrical contact (switch) which can only be in an open or closed position, as determined by a predetermined condition. Examples include firestats, door contacts, alarm devices, pressure switches, flow switches, and motor-starter auxiliary contacts.

Typical analog and binary inputs to an EMS are shown in Table 3-2.

3.2.6 Actuators

Actuators are devices which perform control action at the remote point in response to central system command instructions. Typical actuators connected to FIDs include control motors, valve positioners, damper operators, switches, and relays.

As with input signals, the output signals to the actuators can be classified as either analog or binary. A typical example of an analog output is a temperature indication for control point adjustment.

Table 3-2. Typical EMS Inputs

ANALOG

1. Temperature
2. Humidity
3. Pressure
4. Differential temperature
5. Differential pressure
6. Voltage
7. Watts
8. Amperes
9. KWH
10. Power factors
11. Electric loads/demand level
12. BTU/totalizing
13. BTU/Hr.
14. Air flow
15. Position devices (valves, dampers, etc.)
16. Process variables

BINARY (DISCRETE)

1. Alarms for:
   a. Safety circuit alarm
   b. Firestat alarm
   c. High-temperature alarm
   d. Low temperature alarm
   e. High pressure alarm
   f. Low pressure alarm
   g. Transformer alarm
   h. No flow, flow failure
   i. Dirty filter alarm
   j. Security alarms

2. Status of:
   a. Motor operation:
      i. On/Off
      ii. Run/Stop
      iii. Fast/Slow
   b. Occupied/Unoccupied
   c. Day/Night operation
   d. Heat/Cool
   e. Manual/Automatic
   f. Open/Close

3.3 APPLICATION

Tactical systems are diverse and thus are very difficult to categorize. In most cases the missions of Army units require electrical power. This power is supplied by a variety of power generation devices, ranging from 1.5kW to 750kW, which are listed in MIL-STD-633E, Mobile Electric Power Engine Generator Standard Family General Characteristics. The power required is usually one or more of the outputs in Table 3-3. These outputs are further classified by type (tactical or prime) and class (precise or utility). The type refers to highly mobile (tactical) or

Table 3-3. Standard Military Voltage Connections

1. 28 volts, dc
2. 120 volts, ac, 60 or 400 Hz, 1Ø
3. 240 volts, ac, 60 or 400 Hz, 1Ø
4. 120/240 volts, ac, 60 or 400 Hz, 1Ø
5. 120/208 volts, ac, 60 or 400 Hz, 3Ø
6. 240/416 volts, ac, 60 or 400 Hz, 3Ø (>10kW)
7. 2400/4160 volts, ac, 60 or 400 Hz, 3Ø (>200kW)
8. 2400 volts, ac, 60 or 400 Hz, 3Ø (>200kW)

semi-fixed (prime) configurations and the class refers to the quality of power produced. The precise class outputs are more rigidly controlled with respect to voltage and frequency than the utility class. MIL-STD-1332B, Definitions of Tactical, Prime, Precise and Utility Terminologies for Classification of the DoD Mobile Electric Power Engine Generator Set Family, contains detailed information on the electrical performance characteristics, weight and voltage connections needed.

3.3.1 Controllable Loads

A sufficient number of noncritical loads must exist in order to make investment in EMS cost effective. Such loads typically may include:

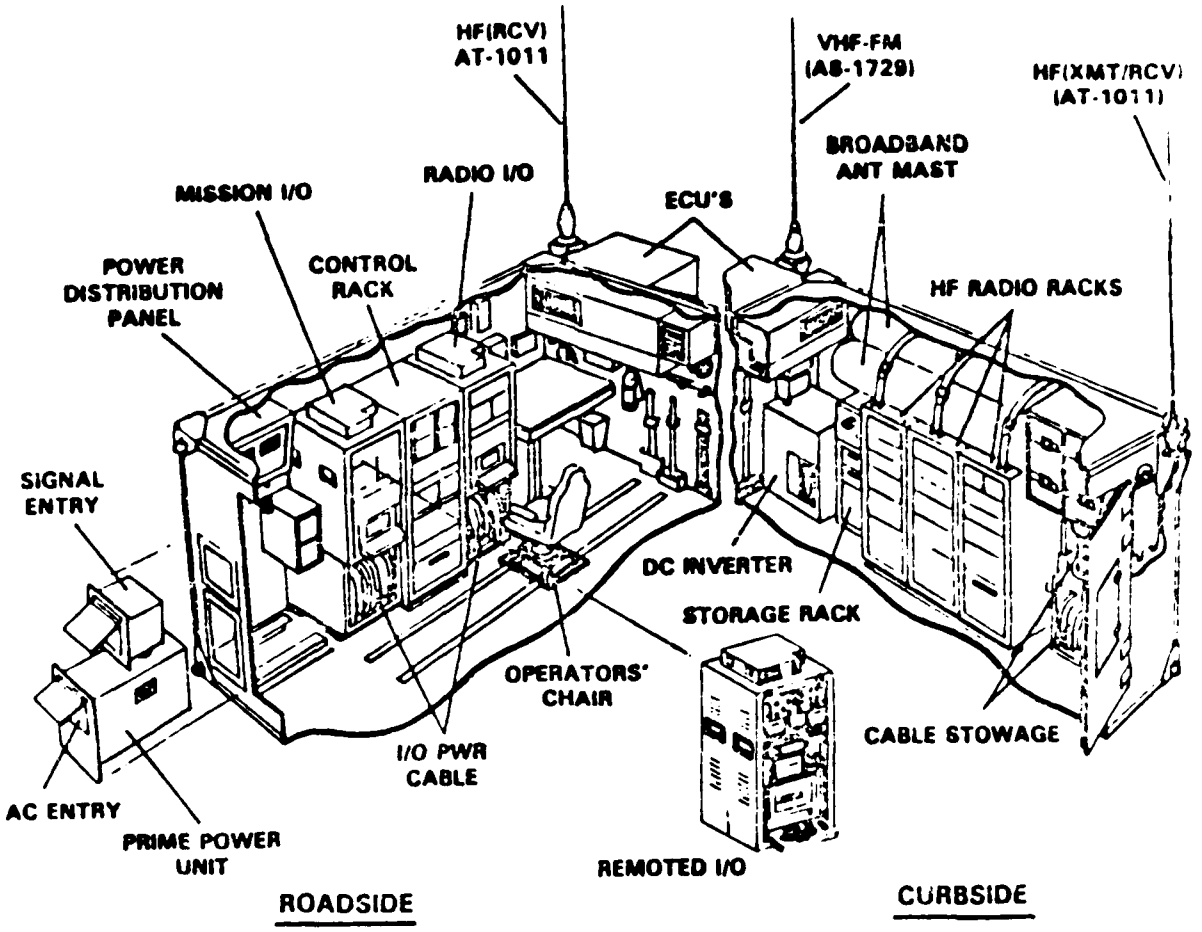
- air conditioners,
- ventilation blowers,
- space heaters,
- lighting,
- water heaters,
- equipment heaters,

- dental compressors,
- autoclaves,
- X-ray systems,
- lens fabrication machines,
- cooking equipment,
- laundry equipment, and
- maintenance equipment.

3.3.2 Configuration of Tactical Military Systems

Tactical systems are diverse and thus are very difficult to categorize. In all cases, however, field forces need 28 volt dc and/or alternating current to fire, deploy and communicate. These electric demands are being met by a variety of gasoline, diesel and turbine engine generators, producing up to 200 kilowatts of power.

One small mobile unit currently being used by the Army is a communications terminal (Figure 3-4) which is air conditioned. The unit typically comes with a 3kW generator. Such a unit does not lend itself to an EMS application unless several units can be grouped together with a single generator supplying the needs of all units. In this application, an EMS can be used to control various noncritical equipment (air conditioning units, heaters, certain communications equipment etc.) in a priority manner to limit the overall demand so that a smaller generator can be used. The priorities are generally established in the field by the user.



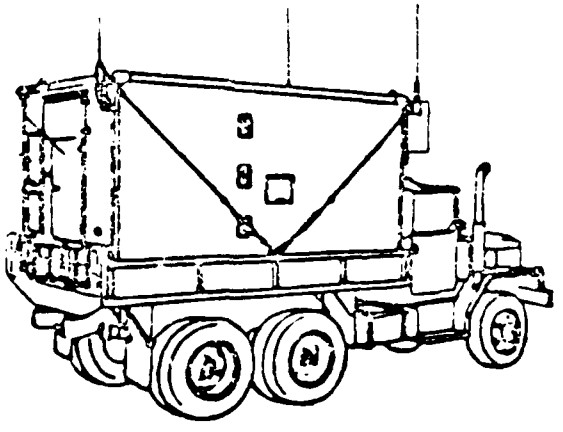


Figure 3-4. Mobile Communication Terminal

A stand alone multifunction microprocessor based EMS (Figure 3-5) is typically used in this application. The executive software is contained within the microprocessor and the applications software is supplied by the vendor. Field panels are not necessary and the controlled equipment is generally hardwired, typically using two wires to the controller.

EMS can also be used to control lighting and other equipment loads associated with small field shelters. However, current electric distribution system designs may have to be modified in order to permit reduction in load through selected switching off of certain branch circuits and utility receptacles. The EMS equipment and configuration involved is similar to that shown in Figure 3-5.

The EMS can also be used in applications involving multiple generators (Figure 3-6). EMS can assume that both generators are operated at peak efficiency. It will also reduce overall peak demand by controlling user specified noncritical loads, thus resulting in the use of smaller size generators.

A field hospital is yet another possible application for EMS. The hospital has a variety of noncritical loads (laundry, sterilizing, water heating, cooking, etc.) which can be controlled by an EMS. The number of control points can range up to 100. As such, the equipment configuration typically will involve the use of multiple field panels (Figure 3-7). Field interface devices may be considered in very large hospitals.

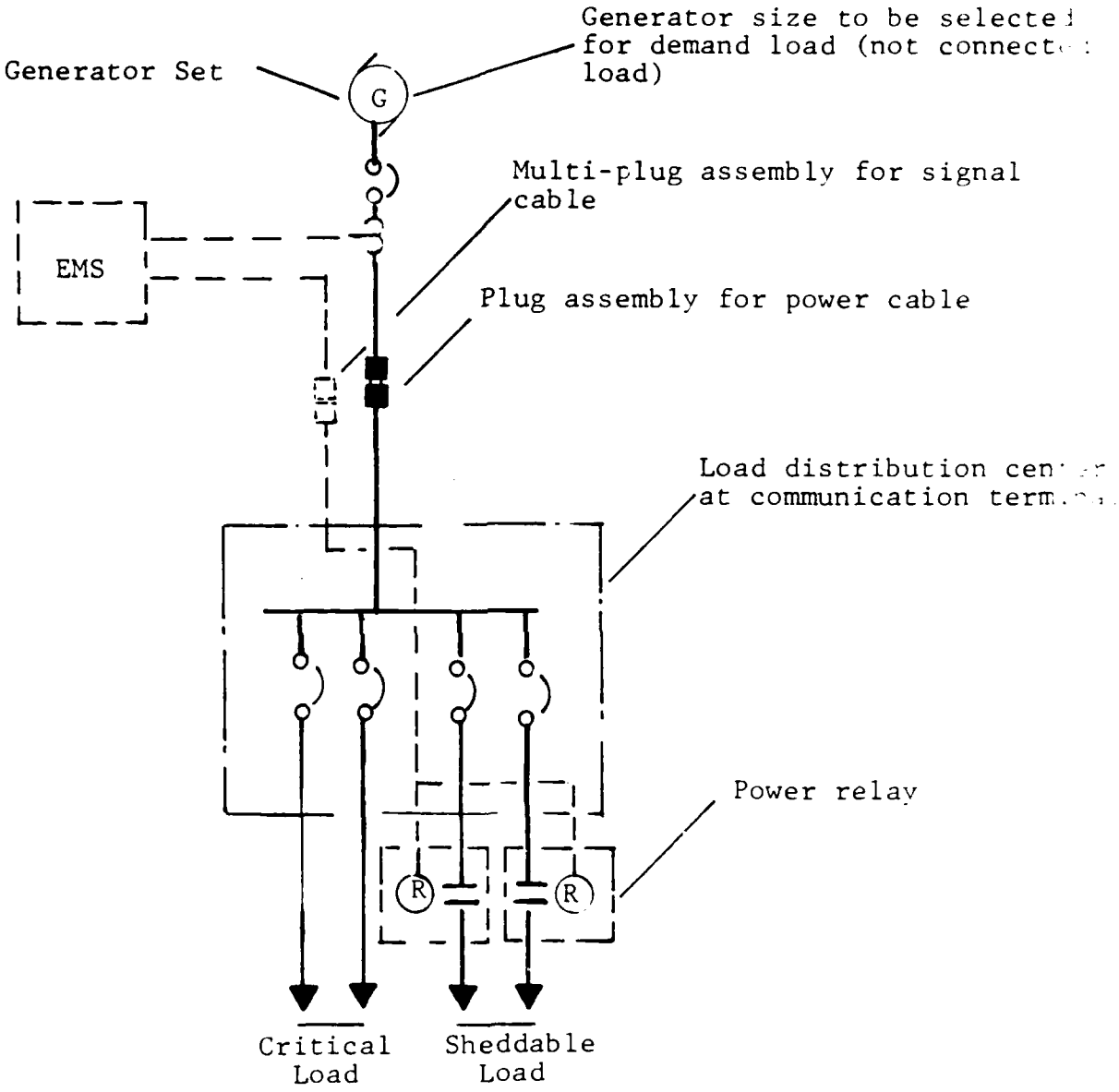


Figure 3-5. EMS Application With Single Generator

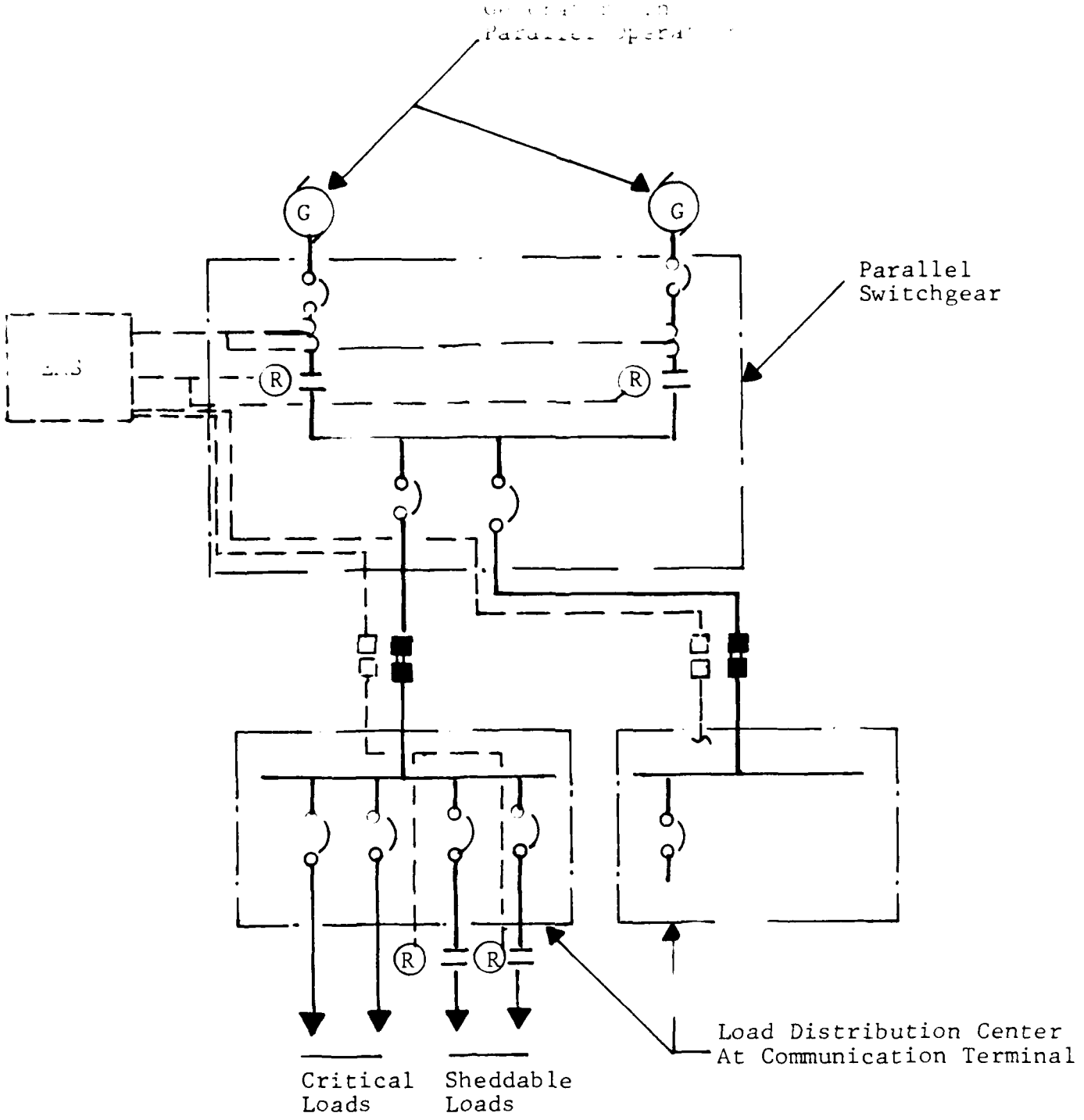


Figure 3-6. EMS Application With Multiple Generators

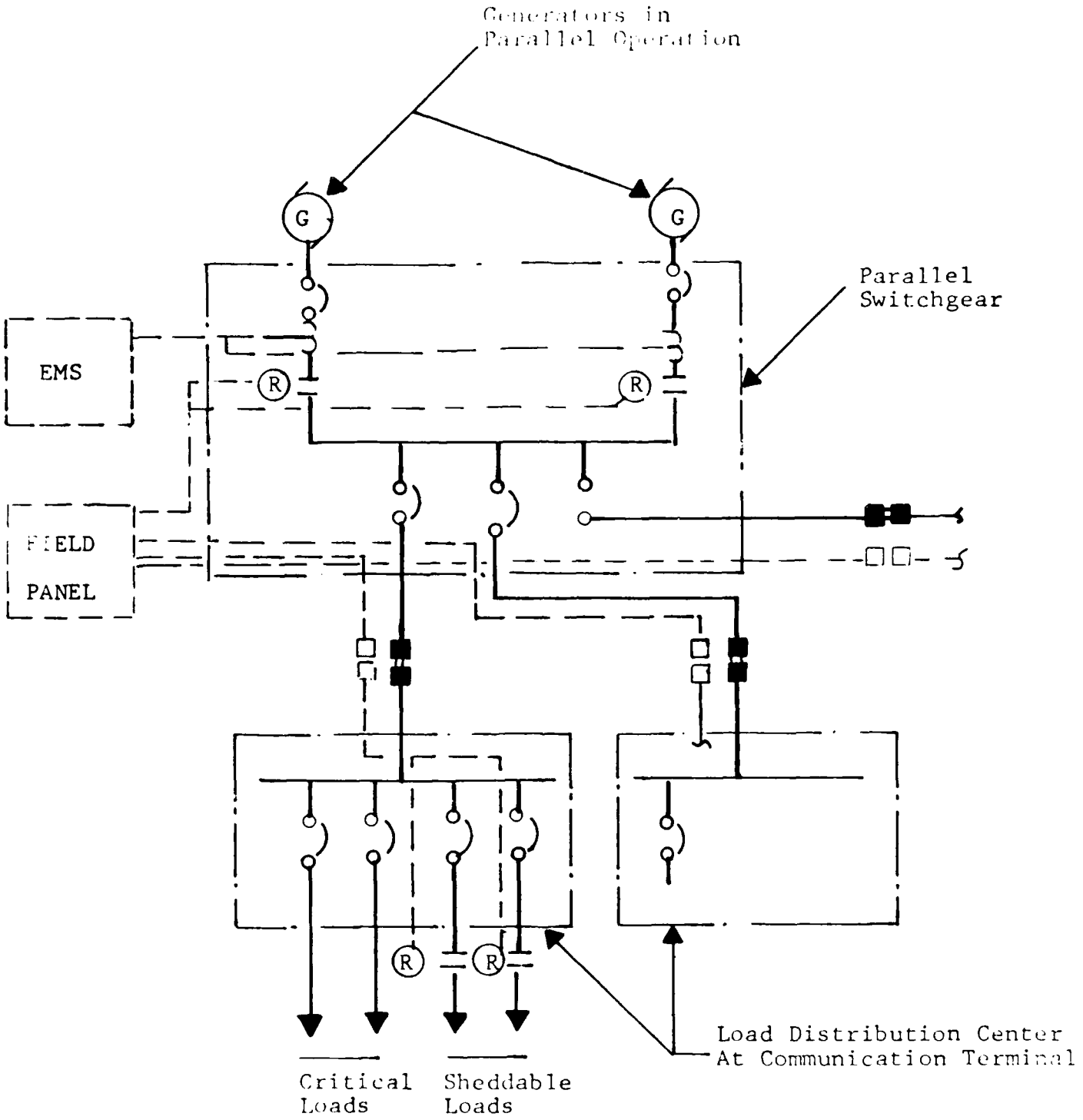


Figure 3-7. Large EMS Application

3.3.3 User Acceptance

The success of any EMS application is dependent on user acceptance. This acceptance can be gained only when the equipment installed performs demand control and other functions in a manner which does not interfere with the mission objectives. Factors influencing user acceptance include: equipment reliability, serviceability, maintainability, ease of operation, cost and adequate operator training, all of which are discussed in Section 4.

Section 4.0

SELECTIC" AND ACQUISITION CONSIDERATIONS

Numerous factors must be considered in selection and acquisition of load management systems. The following discussion highlights many of the specific factors involved.

4.1 USER NEEDS AND EQUIPMENT SELECTION

The success of any application is highly dependent on how well the user needs are defined. In all cases the user must be consulted in order to clearly and objectively define the specific mission objective, critical and noncritical loads, equipment characteristics, schedules, comfort and process concerns, reliability and flexibility considerations, and training needs. A few of the major considerations are as follows.

4.1.1 Functional Requirements

Most of the EMS devices available today provide for multifunction capability. The type of functions to be performed (start/stop, demand control, monitoring, etc.) must be defined before selecting the equipment. Note, the equipment selected should have functional capabilities that closely match needs.

4.1.2 Input/Output Requirements

The input/output requirements are influenced by the type and number of loads that are being controlled and the functions that are being performed. An input/output summary list that defines each point is normally developed during the design phase. This list provides the basis for sizing of the controller and interface devices.

4.1.3 Reliability

Reliability is an important consideration in equipment selection. Both operational and hardware related reliability must be considered.

Operational reliability is the overall probability that a system will operate in a generally trouble-free mode, without failure or interruption, for some predetermined period.

This is generally expressed by manufacturers as "mean time between failures" (MTBF) and average "downtime" per failure. Depending upon the manufacturer, these factors may or may not include average human operator reliability.

Hardware reliability is usually categorized into three modes: infant, normal, and aging failures. Infant failure is associated with malfunction due to poor design, workmanship, or material quality. This mode is characterized by a failure rate that is high in the early stages of use but rapidly decreases with time.

Therefore, the length of time the equipment is guaranteed is very important. A guarantee period of a year usually is sufficient to cover infant failures.

Normal failures are random failures of mechanical or electronic components. This mode is characterized by a relatively constant incidence of failure over time. How much normal failure can be tolerated will determine the amount of redundancy or backup equipment needed.

Aging failures are caused by malfunctions due to excessive wear once the design life expectancy is exceeded. The aging failure period is characterized by an increasing rate of failure over time. Thus, the life of a system must be considered, along with the cost of system replacement versus component replacement.

The data processing and distribution system portion of an EMS is most vulnerable to failure resulting from attempts to defeat controls, poor installation and commissioning, and environmental interference such as line surges.

Energy management systems have generally proven to be reliable. However, for an EMS to function properly and perform the duties for which it was installed, there needs to be a thorough system check-out, adequate operator training and regular maintenance. Without these, an EMS cannot be expected to operate as well as it should.

4.1.4 Environmental and Other Special Considerations

Tactical system applications normally involve environmental conditions that are more severe than those involved in buildings where most EMS applications have occurred to date. Such conditions (temperature and humidity) should be defined and the equipment selected should be certified by the manufacturer to operate normally under these conditions.

Transportability and ruggedness of equipment are other special considerations. Most EMS equipment applicable to tactical systems is relatively small in size and easily transportable. However, none of the current equipment has been tested for ruggedness as required by the Army. As such, before the final equipment is acquired the Army will perform factory tests and certify that environmental and ruggedness criteria are met.

4.1.5 Cost Effectiveness

Cost effectiveness is the basic criteria used in evaluating which type of EMS is best for the application involved and that will result in maximum return on investment. Both cost and benefits are considered in this analysis. The costs of EMS hardware and software varies between manufacturers and the number of points involved. In general, the hardware and software cost for the small microprocessor based systems generally ranges between $7,500 to $10,000. The installation cost typically will amount to an additional $2,000 to $3,000.

The benefits involved with the use of EMS typically are: decrease in dollars spent for usage, more effective utilization of smaller size generation equipment, increased equipment life due to more effective operation, and overall better management of operations.

4.2 DRAWINGS AND SPECIFICATIONS

Once an EMS has been decided upon for a certain application, drawings and specifications -- the contract documents -- must be prepared.

4.2.1 Drawings

The factors generally to be included in a set of drawings are:

4.2.1.1 Block Diagram. Block diagram of the entire system identifies all major components and how they relate to each other (system configuration).

4.2.1.2 Data Transmission Link Configuration. Data transmission link configuration details the network between programmable controllers, field panels (if used) and the various loads.

4.2.1.3 Detail Diagrams. Detail diagrams are needed to convey the designers precise intent to contractors who are called upon to supply and install the equipment. Typical details should be shown for mounting each type of sensing device.

4.2.2 Specification

Some of the major concerns which should be addressed in a specification are:

4.2.2.1 Detailed Component Description of EMS. In the component specification, the type of EMS and the individual components to be used, the quality requirements for accuracy and repeatability, and the software programs to be included must be well defined.

4.2.2.2 Sequence of Operation. A detailed sequence of operation of the system and the equipment to be controlled must be developed and specified. In addition to initiation and normal operation, failure modes are essential.

4.2.2.3 Installation Procedures. The procedures used in locating and physically installing all EMS hardware (controllers, sensors, activators, etc.) should be fully described in the specification.

4.2.2.4 Documentation. The operators and other documentation of the procedures for operating the system are the keys to a successful installation. Their requirements should be fully detailed in the specification. As a minimum, the operator's manual should include the following information:

- System initialization procedures
- Command descriptions

- Alarm processing
- Failure-recovery procedures
- Backup equipment operation
- Reports/alarm message
- Formats
- Preventive maintenance schedule
- EMS nominal operations

The documentation should describe the system where sensors are located, typical performance ranges and will also include the requirements of the operational software system of the computer.

4.2.2.5 Startup Requirements. A detailed description of how the system is to be put into initial operation and how each point is to be calibrated and checked is essential. This description should also tell which programs will be used initially and how, and in what sequence other programs will be implemented.

4.2.2.6 Guarantee. The guarantee requirements of the various components and the entire system are an inherent part of the specification. The key determination is when the guarantee period begins. This subject should be spelled out as part of the commissioning procedure and is usually based on when the owner begin receiving "beneficial use" of the system. It is important that a full service contract be specified to run concurrently with the guarantee period. Further, final acceptance of the system should be clearly noted.

4.2.2.7 Nontechnical Specification Information. The specification must include the necessary legal and administrative information, usually referred to as "boiler plate," to assure that the responsibilities of all parties are understood and are binding.

4.3 SYSTEM PROCUREMENT

An EMS is procured much in the same manner as any other major purchase.

Procurement methods range from the simple negotiated sale to the more detailed two-part procurement and request for proposal methods. The selected method of procurement, however, depends on a number of factors greatly influenced by the needs of a particular facility or its owners.

Regardless of the procurement method used, potential vendors should be screened to gather additional information about them, such as their track records and references, and their specific approach to the project.

Bids should be obtained from several reputable suppliers. All bidders should be required to utilize generic terminology, as defined in the specifications, and should indicate those elements of plans and specifications with which they are unable to comply; available alternatives which provide a similar function; and

alternatives and options, which may not have been considered along with the cost of the hardware and software.

Contract award should **not** be based on low bid alone. Rather, it should be based on **value**, employing an evaluation of the cost-benefits of each proposed system.

4.4 TRAINING

Personnel must be trained so they understand the concepts involved, how to perform their individual functions, and how the functions interrelate with those of others and the operation of equipment.

4.5 INITIAL OPERATION OF A SYSTEM

The system should be started up in its simplest mode. Care should be taken not to allow it to control functions or actuate alarms until its basic performance is verified and its reliability established.

4.6 ACCEPTANCE TESTING

After the system has been installed but before it has been accepted, a comprehensive program of acceptance testing should be pursued. In this regard, it should be noted that the Department of Defense has sponsored the development of a series of EMS acceptance tests and checks to help ensure that new systems will perform properly and reliably prior to their being turned over to the government.

Specifically, all EMSs to be installed on military bases are now subjected to rigorous factory tests prior to being shipped, and they are given a 30-day operating test after installation and prior to acceptance.

4.7 FINE TUNING

As the system is operated, the actual performance of the controlled equipment will be apparent, and the program changes will be desirable. Sensors should be rechecked for accuracy and the overall system fine tuned for optimal performance.

4.8 MAINTENANCE

Planned preventive maintenance and regular servicing of the system are required to ensure reliability. Even if minimal service is required, it should be planned and performed by well qualified personnel. Updating of software and ongoing training will be necessary parts of the planned maintenance program.

Section 5.0
RECOMMENDATIONS

EMS equipment can be used to manage the electrical demand imposed by tactical military systems, and to thus minimize the extent of generating equipment needed in the field. More research is required to develop specific recommendations for application.

5.1 DOCUMENT APPLICATIONS AND USER NEEDS

More information is required to define military tactical systems and to identify specific user needs. This information comprises knowledge of the tactical systems equipment and configurations and the electrical characteristics and requirements of the equipment to which load management would be applied. Electrical and operational data on all electrical equipment should be developed along with usage and load profiles. It is recommended that such data be developed through meetings with users.

5.2 CONDUCT A DETAILED FEASIBILITY ANALYSIS OF EMS APPLICATION

A detailed feasibility analysis of EMS application should be undertaken after applications and user needs have been identified. The feasibility analysis will specifically document cost/benefits associated with EMS in various applications. Only

those applications that are cost-effective and are likely to gain high user acceptance will be considered for the demonstration effort.

5.3 DEVELOP DESIGN DETAILS AND SPECIFICATION

Design details should be developed for systems that are cost-effective and meet user needs. Performance specifications should also be developed for different application needs and system configurations.

5.4 DEMONSTRATE APPLICABILITY

At least two applications should be selected for field demonstration of EMS. These demonstrations will involve working with two different types of manufacturers involving two different types of EMS (one that can only perform demand control and another that can perform demand control, duty cycling and optimized start/stop, logging and monitoring functions as well). All aspects (EMS cost, equipment characteristics, operating parameters, generator size and loading, reliability and user experience) will be fully documented.

5.5 DEVELOP OPERATOR MANUALS

Operator manuals should be developed in order to describe sequence of operating as well as system operating and maintenance procedures.

Section 6.0

GLOSSARY

Actuator:	A device, either electrically, pneumatically, or hydraulically operated, which changes the position of a valve or damper.
Address:	A coded representation of the origin or destination of a data message.
Alarm:	A warning signal indicating that a condition is not normal and not within operating limits.
Algorithm:	A rule or procedure for solving a recurrent mathematical problem.
ALU, Arithmetic/Logic Unit:	That part of the CPU which executes, adds, subtracts, shifts, ANDs, ORs, etc.
Analog to Digital Converter:	A circuit or device whose input is information in the analog form and whose output is the same information in digital form.
Annunicator:	A device to bring to the attention of the operator the condition or status of a point.
Application Program:	A program which performs the specified functions of a system. All programs other than the executive system and routines common to all systems fall into this category (e.g., a trend log program).
ASCII(American Standard Code for Information Interchange):	An 8-bit coded character set to be used for the general interchange of information among information processing systems, communication systems and associated equipment.

Asychronous:	Having a variable time interval between successive bits, characters or events. A nonconstant rate.
Asynchronous Computer:	An automatic digital computer in which each operation starts as a result of a signal generated by the completion of the previous event or operation, or by the availability of the parts of the computer required by the next event or operation.
Background Programming:	A feature of computer hardware to provide a means of writing, testing, and debugging a software program on the computer at the same time the computer is performing other "Real Time" programs.
BASIC:	An acronym for Beginners All-Purpose Symbolic Instruction Code, a high-level, English-like programming language used for general applications.
Battery Backup:	A feature which causes the computer to use standby battery power to maintain memory and supply critical circuits if a power failure occurs.
Baud:	A unit of signalling speed. Speed in bauds is the number of signalling elements persecond (Bits/sec). While baud can be expressed in bits per second when each signal event represents only one bit, some codes permit each signal event to represent other than one bit per baud.
Binary:	Capable of occupying only either of two states, such as on/off for a motor, high/low for a logic circuit, etc.
Binary Point (Sensor):	A sensor whose output indicates that either a monitored characteristic exists or it is zero.
Bit:	A data element which is either a "zero" or a "one."

Bit Error Rate:	The number of incorrect or erroneous bits divided by the total number (correct plus incorrect) over some stipulated period of time.
Byte:	A group of eight bits.
Cable:	Insulated electrical conductor(s) covered with a protective sheath.
Card:	A hardwired piece of equipment located in the remote panel that is specially wired for remote point functions.
Cathode Ray Tube (CRT):	An electron beam tube in which the beam is focused to a small cross section on a luminescent screen and varied in position and intensity to produce a visible pattern.
Charge-Coupled Device (CCD):	A special MOS fabrication process.
Central Memory:	Core or semiconductor memory communicating directly with a central processing unit. (Also, main frame memory.)
Central Processing Unit (CPU):	The portion of the computer (CCU) that performs the interpretation and execution of instructions. It does not include memory or I/O.
Character:	One of a set of elementary symbols which normally include both alpha and numeric codes plus punctuation marks and any other symbol which is read, stored, or written.
Clock:	A device or a part of a device that generates all timing pulses for the coordination of a digital system. System clocks usually generate two or more clock phases. Each phase is a separate, square wave pulse train output.
Closed-Loop Control:	An operation where the computer applies control action directly to the process without manual intervention, measures process response and automatically applies any additional corrective action required.

Computer:	A device capable of solving problems by accepting data, performing prescribed operations on the data, and supplying the results of these operations.
Controller:	A device that measures changes in controlled variables in rooms, ducts, and liquids and sends an appropriate signal to adjust such system functions.
Controls:	Devices which govern the performance of a system.
Control Sequence:	Equipment operating order established upon a correlated set of data environment conditions or variable computer program.
Control Set Point Adjustment:	A method by which the analog set point of a controller is changed to a new value.
Core Memory:	A magnetic type of memory where each storage element is usually made up of individual miniature toroids. Each toroid (core) can be magnetized in one direction or the other, representing a "0" or a "1", that is, a single bit. This type of memory is permanent in that if power is removed, the stored information remains.
Data:	A collection of facts, numeric and alphabetical characters, which is processed by or produced by a computer.
Data Communications Equipment:	A communication interface device for converting digital information to and from a communicable form.
Data Transmission Media (DTM):	Transmission equipment including cables and interface modules (excluding MODEMs) permitting transmission of digital and analog information.
Debug:	The procedure of running a program to detect and correct errors in a program.

Demand:	The term used to describe the maximum rate of use of electric energy averaged over a specific interval of time and usually expressed in kilowatts.
Demultiplexer(DeMUX):	A device which separates combined multiplexed signals from a common medium to individual lines.
Diagnostic Program:	Machine executible instructions used to detect and isolate component malfunctions.
Digital:	A non-continuous or pulsed signal which is either on or off (zero or one).
Direct Digital Control (DDC):	Sensing and control of processes directly with digital electronics.
Digital to Analog (D/A) Converter:	A hardware device which converts a digital signal into a voltage or current proportional to the digital input.
Discrete:	Separate, distinct.
Distributed Processing System:	A system of multiple processors each performing its own task, yet working together as a complete system under the supervision of a central computer, to perform multiple associated tasks.
Download:	The transfer of digital data or programs from a host computer to another data processing system such as central computer to micro-computer.
Duplex:	Simultaneous two-way independent transmission.
EMS:	Energy management system.
Encoder:	A remote device that responds to a request to transmit its encoded information to a central station. In its simplest form, a relay.
Executive Software:	The main system program designed to establish priorities and to process and control other programs. Sometimes called the Operating System.

Field Interface Device (FID):	A small, intelligent hardware device containing software which implements the distributed processing aspects of operation with the central computer as well as maintaining effective control of field control loops in the absence of higher level influence. Operating constants are changed by down-line loading from the CCU as well as from within the FID.
Format:	The predetermined arrangement of fields, lines, page numbers, functions and similar characters.
Full Duplex Transmission:	The transmission of data in two directions simultaneously over two pairs of wires.
Graphic Display:	A pictorial representation of a control system. Usually engraved in formica or silk-screened. A multicolored projection of a system schematic or floor plan showing the address of all inputs to the addressed automation system.
Hardware:	The mechanical, magnetic, electrical and electronic devices of which a computer is built, as well as the similar components of peripheral devices.
Hard-wired:	Pertaining to wiring systems in which conductor pairs for each signal are run between the control center and the signal source or destination. Non-multiplexing.
High-Level Language:	A high level language in a problem-oriented or procedure-oriented programming language allowing the programmer to express operations in a less direct form than machine oriented or mnemonic languages.
Indication:	A visual display of status.
Input/Output (I/O) Device:	Hardware that transmits or receives data.

I/O Bus:	The connection through which data is transmitted and received from peripheral devices wishing to interact with the processor.
Intelligent Multiplexer (IMUX):	A device that combines data from a number of points in the data environment and communicates on a single channel in the "report by exception" mode.
Interactive:	Functions performed by an operator with the machine prompting or otherwise assisting these endeavors, while continuing to perform all other tasks as scheduled.
Interface:	A common boundary between automatic data processing systems or parts of a single system.
Interrupt:	A signal requesting that current operations be suspended to perform more important tasks. The interrupt can be internal or external and can be originated by a hardware device or by software.
K:	(as in 64K words) 1K = 1024.
Loader:	A program used to prepare and store other programs into memory locations in preparation for machine execution.
Local Loop Control:	The controls for any system or subsystem which existed prior to the installation of an EMCS and which will continue to function when the EMCS is nonoperative.
Machine Language:	The binary code corresponding to the instruction set of the CPU.
Memory:	Any device that can store logic Ø bits in such a manner that a single bit or group of bits can be accessed and retrieved.
Memory Address:	A binary number that specifies the precise memory location of a stored word.
Memory Modules:	Increments of memory, usually 4K, 8K, or 16K words in length.

Microcomputer:	A computer system based on a microprocessor and containing all the memory and interface hardware necessary to perform calculations and specified transformations.
Microprocessor:	A central processing unit fabricated as one integrated circuit.
Minicomputer:	A small computer with short word lengths, and limited processing capabilities.
MODEM:	An acronym for MOdulator/ DEModulator. A hardware device used for changing digital information to and from an analog form to allow transmission over voice grade circuits.
MOS, Metal-Oxide Semiconductor:	One of two key solid-state technologies for the fabrication of large, low-cost memories with very high input impedance MOS variations: P (p-channel), N (n-channel), D (double diffused), V (v-groove), etc.
Multiplexer (MUX):	A device which combines multiple signals on one transmission media.
Object Code:	A term used to describe machine language.
Open Loop Control:	An operation where computer-evaluated control action is applied by an operator.
Operating System:	Software which controls the execution of computer programs and which may provide scheduling, debugging, input/output controls, accounting, compilation, storage assignment, data management, and related services.
Optimization:	The process of operating an environmental system at maximum efficiency, i.e., obtaining the desired environmental conditions at all times with the least consumption of energy. The computer is instrumental in

	simultaneously evaluating multiple variables and controlling the environmental equipment accordingly.
Parameter:	An element which can be assigned constant or variable value in a particular computing process.
Peripheral:	Input/output equipment used to make hard copies or to read data from hard copies (typewriter, punch, tape reader, line printer, etc.). Paper tape is considered hard copy for this definition.
Point:	Actual input to or output from the EMS from or to the systems being monitored and controlled.
Point (analog):	Finite address having a variable value such as: 456 psig, 60 gpm, 72F, 20 ma.
Point (discrete):	Finite address having a discrete value such as: On, Off, Opened, and Closed.
Program:	A sequence of instructions causing the computer to perform a specified function.
Protocol:	A formal set of conventions governing the format and relative timing of message exchange between two terminals.
Random Access Memory (RAM):	Volatile semiconductor data storage device in which data may be stored or retrieved. Access time is effectively independent of data location.
Real Time:	A situation in which a computer monitors, evaluates, reaches decisions and affects controls within the relaxation time of the fastest loop or specified response time.
Receiver Controller	A device that accepts the signal produced by a transmitter and converts it for suitable operation of the controller device.

Relay:	A device for converting an electrical or pneumatic signal into an electromagnetic switching device having electrical contactors energized by electrical current through its coil.
ROM, PROM, EPROM, EEPROM:	Read-Only-Memory, Programmable ROM, Erasable PROM, Electronically Erasable PROM. All are non-volatile semiconductor memories.
Resistance Temperature Detector (RTD):	A device where resistance changes linear as a function of temperature.
Scan:	To examine stored information for a specific purpose as for content and arrangement; to examine the status of input/output channels to determine whether data is being received or transmitted.
Sensing Element:	That part of the transducer that responds directly to the measurand.
Sensors:	Devices used to detect or measure physical phenomena.
Simulation:	The process of making one computer act like another through software. Also, the process of running a program using artificially hypothetical data.
Software:	A term used to describe all programs whether in machine, assembly, or high-level language.
Stand-Alone:	A term used to designate a device or system which can perform its function totally independent of any other device or system.
Transducer:	A device that provides a useful output in response to a specific measurand. Generally, any device converting one form of energy to another, such as mechanical to electrical, electrical to mechanical, etc., in which the output is some analog of the input.

Transmitter:	A device that conditions a low level signal for transmission to an indicating device for indicating and/or to a receiver controller for conditioning into a final control signal.
UPS:	Uninterruptable power supply.
Volatile Memory:	A semiconductor device in which the stored digital data is lost when power is removed.
Word:	A series of bits, generally of consistant length, containing numerical or coded information.

Section 7.0

REPORT DISTRIBUTION LIST

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APPENDIX A

REMOTE CONTROL SYSTEMS

All remote control systems consist essentially of three major components: a central controller, the communication system, and receiver switches. Several communication systems exist: radio frequency systems (VHF-FM), ripple, powerline carrier, and a combination radio frequency/powerline carrier. Of all these communication systems, radio frequency systems are the most frequently used, due to features such as low cost, simplicity of operation, and proven high reliability.

CENTRAL CONTROLLER

The central controller, typically computer-based, determines when and how control is to be exercised. A message generator, a sub-component of the central controller, creates the actual load control command and receiver switch address messages. These messages are then transmitted to the receiver switches using the system's communication vehicle.

COMMUNICATION SYSTEM

The communication system utilized is the principal element differentiating one system from another. Several different communication systems are presently being used. Information on each is provided below.

Radio

The VHF-FM radio system (Figure A-1) is the most widely used remote control system in the United States: about 60% of all utility remote control systems are VHF-FM radio systems. The relatively low cost, simplicity, and proven high reliability of FM radio systems have led to their wide utility acceptance. The simplicity of a radio system, however, also imposes limitations. Geographic and man-made structures reduce radio signal propagation to an effective range of 8 to 40 kilometers (5 to 25 miles) for a 300-watt transmitter. This power limitation, imposed by the Federal Communications Commission (FCC) regulations, can be circumvented by adding remote transmitters with an overlapping signal range, but such additions increase costs. If the utility already has a radio communication system in place -- for mobile communications and service crew dispatch -- existing transmitters can often be used. This ability adds to the attractiveness of radio control.

Most radio systems used today operate at a frequency of approximately 154 MHz, but several systems have been installed that operate at 48, 138, or 174 MHz.

A radio receiver switch is a combination self-contained FM receiver (tuned to the system's operating frequency), message decoder, and relay. The message decoder, which is the device's logic section, allows it to operate only when it receives a preprogrammed address command.

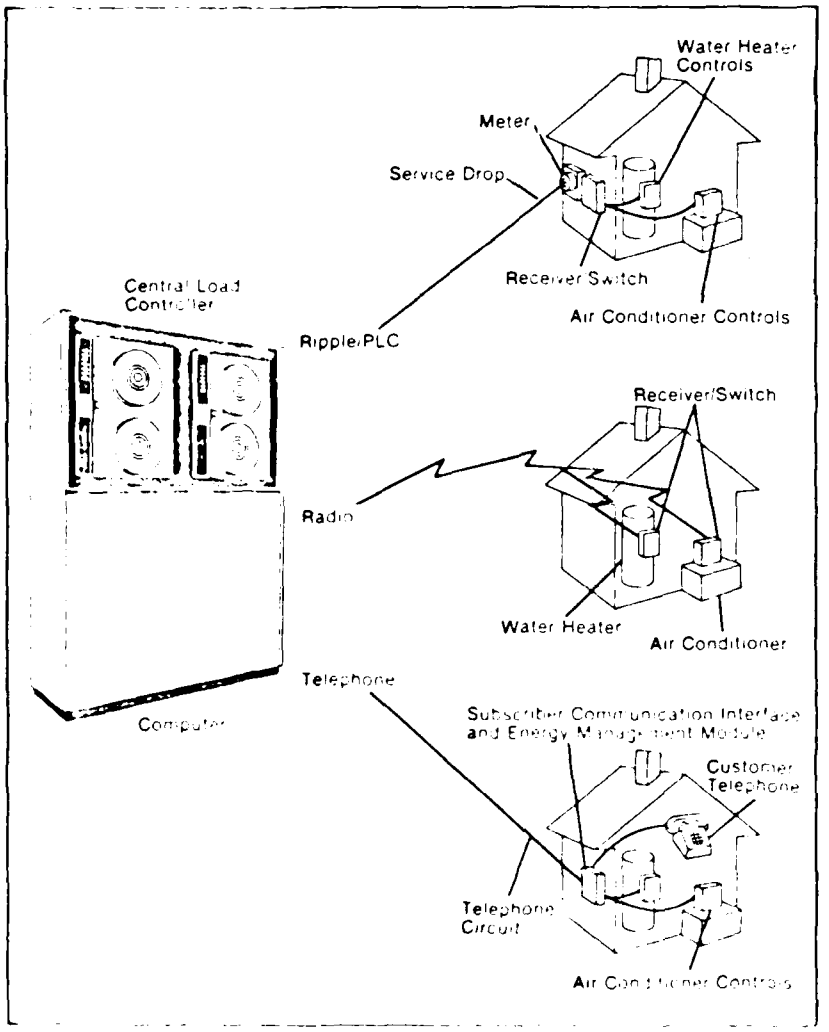


Figure A-1. Typical Remote Control System

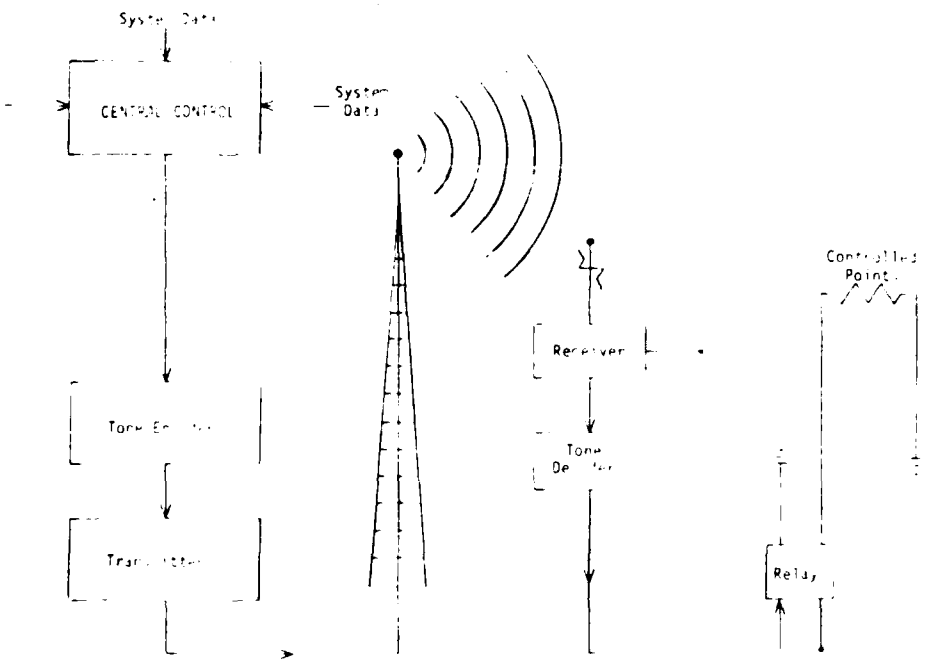


Figure A-2. Unidirectional Radio Load Control System

Two basic types of message-decoder systems are used today: tone-based and digital-based systems.

Once the radio switch receives and decodes a control command, it responds by opening its relay, thereby interrupting operation of its designated control load.

The most common type of radio receiver used today is a single-function (designed to control only one load) receiver switch with a 240-vac, 30-amp or a 24-vac, 5-amp control relay.

Ripple

Ripple control systems have been used extensively in Europe and

other parts of the world for many years. Approximately 13% of the remote control systems in the United States are of this type. A ripple control system, sometimes referred to as low-frequency powerline carrier, uses a utility's transmission and/or distribution network as the transmission medium.

In this system, audio frequency impulses, typically in the 200- to 150-Hz range, are superimposed or "injected" on the normal 60-Hz line voltages via ripple control transmitters typically located in distribution substations. At these low frequency levels, signals propagate over long distances and through transformers and capacitors with little attenuation. Conversely, normal line noise is relatively high at these frequencies; therefore, the injected impulse must be at a high enough power level to maintain an acceptable signal-to-noise ratio.

The impulses generated by the transmitter are injected onto the lines in preset patterns of various coded sequences which are, in turn, received and decoded by ripple control receiver switches.

Powerline Carrier

A powerline carrier system operates on essentially the same principle as a ripple control system; that is, the medium for transmitting signals between the point of origin and the point of control is the utility's distribution system.

A powerline carrier system, however, operates at higher frequency levels, in the 3- to 15-kHz range. The use of these high

frequencies offers several advantages. At frequency levels above 3-4 kHz, normal powerline noise (resulting from harmonics, for example) drops off rapidly; consequently, a signal transmitted at or above these frequency levels requires less signal power for an acceptable signal-to-noise ratio than would a signal operating in lower frequency ranges.

With the higher frequency systems, signal generation is easier and less expensive, and there is greater potential for bi-directional communication (used for remote meter reading and status monitoring). Conversely, signal propagation is shorter because of the signal attenuation on a line designed for 60 Hz and when passing through transformers and capacitor banks.

Combination Radio and Powerline Carrier

Approximately 9% of the reported remote control systems used are combination radio and power line carrier systems. This type of system is a hybrid application of two communication technologies and uses the same major components as a radio control system with the addition of several elements of a powerline carrier system. Functionally, the system closely resembles a radio control system because load management signals originate at a control center and are then transmitted, via an FM radio transmitter, to radio receivers located throughout the service territory.

In this hybrid system, the radio receivers are located on distribution transformer poles. This pole-mounted receiver is

connected to a small powerline carrier transmitter, the output of which is coupled to the secondary of the distribution transformer. The pole-mounted receiver, upon receiving the proper load management command from central control, activates the powerline carrier transmitter which relays the control commands over the secondary powerlines to the customer locations via a frequency-modulated carrier signal. These commands are received and decoded by powerline carrier receiver switches at the customer's location.

Other Systems

Several additional remote control technologies are available to the utility industry although none has been as extensively applied as the systems already described.

Like ripple and powerline carrier systems, one relatively new system uses the utility's distribution system as the communication medium. Unlike ripple and powerline carrier, however, this system signals by altering the time between zero crossings of 60-Hz sine waves. This alteration is achieved by the addition of a low level, single-phase cycle (60-Hz) sine wave voltage whose phase angle is displaced 90 degrees from the supply voltage. This system, with the trade name TWACS, (two way automatic communication systems), was developed by the New England Electric Systems.

[illegible] lines have been used to carry load control commands. [illegible] lease dedicated telephone lines for controlling

large commercial and industrial loads. A few utilities have secured agreements to interface with telephone company central switching systems thereby gaining access to a high-quality communication network that reaches thousands of end users. The inter-relationships between two utilities (telephone and electric) and the complications arising from the issues of system control and ownership and use tariffs have created many institutional problems that remain unresolved. Because of these problems, the use of telephone on a scale larger than just a few dedicated points has been extremely limited.

Existing cable TV (CATV) systems have also been recognized for their extremely high-quality utility communication potential. Constraints, such as limited CATV penetrations in given service territories and institutional factors (as described with telephone lines), have limited the use of CATV networks for remote control applications to just a few cases.

Another technology being applied for remote load control on a limited basis also requires that the utility interface with an outside entity. Commercial AM or FM radio systems have been developed to allow load management signals to be "piggy-backed" on the subcarriers of powerful commercial radio stations. Using these powerful signals offers the potential for using lower-cost, lower-sensitivity receiver switches, and promises a highly reliable communication network. The Federal Communications Commission (FCC) has authorized the use of these subcarriers for

load management. Previously their use was permissible only under special case-by-case authorization. This technology is, however, being tested by several utilities, and several others have expressed interest in it.

RECEIVER SWITCH

The receiver switch is a combination signal receiver, decoder, and switch that responds to a remotely sent message by energizing a relay coil, thereby opening a circuit and interrupting power to a controllable load.

Most receiver switches used today are single-function devices intended to control only one load. Several utilities are, however, using dual-function receiver switches with two relays to independently control two separate loads. Some equipment manufacturers offer optional receiver switches with up to six independent control functions.

Most receiver switches have a fail-safe feature that allows the controlled load to resume operation within a set time-out period. The receiver switch automatically restores the previously switched-off load after the time-out interval unless it first receives another control signal.

Control message decoding is an important characteristic of a receiver switch. Control strategies employed typically stagger the on and off switching of loads in order to achieve a desired

level of control that causes minimal discomfort to individual customers. Thus, utilities benefit from the ability to signal small groups of receiver switches that can respond independently from all other switches on the system. To allow this approach, receiver switches are designed to respond only to signals that carry a preprogrammed code or address.

APPENDIX B

SELECTED LIST OF EMS EQUIPMENT MANUFACTURERS

AET Systems, Inc.
77 Accord Park
Norwell, MA 02061

AMF Paragon Electric Co.
606 Parkway Blvd.
PO Box 28
Two Rivers, WI 54241
(414) 793-1161

Advanced Micro Systems
9076 N. Deerbrook Trail
Milwaukee, WI 53223
(414) 355-7535

Allen-Bradley
A Rockwell International Company
Industrial Control Division
1201 S. Second St.
Milwaukee, WI 53204

American Auto-Matrix Inc.
1 Technology Drive
Export, PA 15632

Andover Controls Corporation
York & Haverhill Streets
Andover, MA 01810
(617) 470-0555

Barber-Coleman Co.
Environmental Controls Div.
1354 Clifford Avenue
PO Box 2940
Loves Park, IL 61132
(815) 877-0241

Butler Manufacturing Co.
PO Box 2249
Kirkland, WA 98083
(206) 823-7100

Computer Controls
54 Industrial Way
Wilmington, MA 01887
(617) 658-5690

Controlled Energy Systems Co.
1240 N.E. 175th Street
PO Box 55548
Seattle, WA 98155

Enercon Data Corp
7464 W. 78th Street
Minneapolis, MN 55435
(612) 829-1900

Encon Systems, Inc.
502-F Vandell Way
Campbell, CA 95008
(408) 866-1711

Energy Management Corporation
9 Schilling Road
Hunt Valley, MD 21031
(301) 683-3500

Honeywell, Inc.
Energy Products
1985 Douglas Drive North
Golden Valley, MN 55422
(505) 831-7000

IDEC S&C Corporation
1213 Elko Drive
Sunnyvale, CA 94089-2211
(408) 747-0550

Klockner-Moeller Corporation
4 Strathmore Road
Natick, MA 01760
(404) 952-0258

Margaux Controls
2980 N. First Street
San Jose, CA 95134
(408) 942-0909

MCC Powers, a Unit of
Mark Controls Corp.
2942 MacArthur Blvd.
Northbrook, IL 60062
(312) 272-9555

MicroMizer, Inc.
3280 W. 14-Mile Road
Royal Oak, Michigan 48073
313-435-2210

MicroControl Systems, Inc.
6579 N. Sidney Place
Milwaukee, WI 53209
(414) 351-0281

Savergy, Energy Systems, Inc.
1404 Webster Avenue
Ft. Collins, CO 80524

Seaboard Energy Systems, Inc.
PO Box 5459
Va Beach, VA 23455
804-490-9261

Solidyne Corporation
2207 Hammond Avenue
Schaumberg, IL 60195
(312) 397-8500

Spartan Technology, Inc.
PO Box 1784
Albuquerque, NM 87103
(505) 892-5300

Square D Company
SY/MAX - Dept. SA
PO Box 472
Milwaukee, WI 53201
414-332-2000

Synergetics International
PO Box E
Boulder, CO 80306
(303) 530-2020

Toshiba Houston
13131 West Little York
Houston, Texas 77041
1-800-231-1412

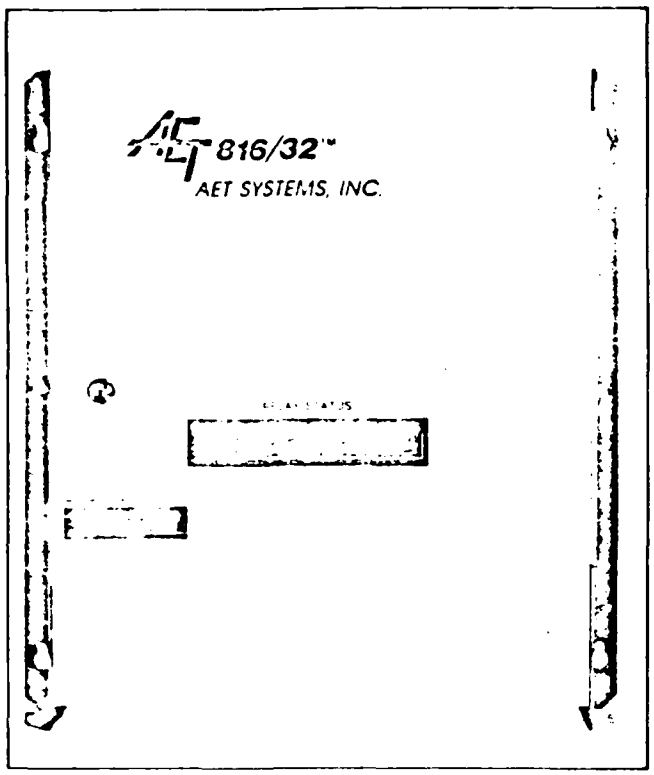
Trane Company
12320 Parklawn Drive
Rockville, MD 20852-1786

Triangle Microsystems, Inc.
8600 Jersey Court
Raleigh, NC 27612
(919) 782-2367

APPENDIX C

SELECTED ENERGY MANAGEMENT SYSTEMS

SPECIFICATIONS



AET 816/32™

ENERGY MANAGEMENT SYSTEM AND DIRECT DIGITAL CONTROLLER

DESCRIPTION

The AET 816/32 is a microprocessor based programmable controller designed for the management of mechanical equipment and energy loads as well as specific process functions. It operates stand alone, as an element of a control network, or as an intelligent peripheral in a central processor-based control monitoring system.

TYPICAL APPLICATIONS

- Night & weekend setback
- Duty cycling
- Load shedding
- Optimized start-stop
- Enthalpy control
- Outdoor reset
- Temperature control
- Sequenced start-up
- Holiday scheduling
- Chiller control
- Boiler control
- Pulse Width Modulation
- Emergency and alarming
- Power loss response
- Floating temperature control

FEATURES

- User programmable - up to 16 independent programs
- Calendar year programmability
- Data file maintained on all inputs/outputs
- Telephone communications and diagnostics
- Full battery back-up
- Security passwording
- Auto dial and alarming capabilities
- Continuous internal diagnostics
- Remote indication of override switch positions
- Full math capability for DDC, PID and PWM
- Clear English labelling of inputs and outputs
- Automatic engineering unit conversion of analog values and digital inputs

HARDWARE

AET 816/32 employs a Motorola 6803 microprocessor with proprietary analog and digital I/O circuitry plus 16K of on-board 2K by 8 byte wide CMOS RAM, and 16K of 4K by 8 UVE PROM. Screw terminal access is provided for 16 analog inputs, 8 discrete digital inputs, 8 relay outputs plus 4 bits and a 20mA current loop for inter-unit communications. An RS232C port is standard. Pre-wired cables with connectors are provided for power supply, battery back-up and RS232C connections to the PC board itself.

Indication of override switch positions as well as user-programmed auto dial and/or alarm signals are available via the RS232 port

SOFTWARE

Each AET 816/32 is furnished with a programming manual and user instructions based on clear English AET-CONTROL language. 35 Common mechanical terms are symbol-defined and factory-loaded into the unit's PROM along with +, −, ×, ÷, >, <, and = capability for ease of user programming. AET 816/32 can sustain 16 independent programs of 64 lines each @ 59 characters/line. Full algebraic capability for PID, PWM and DDC is inherent in the software. User can program any desired interrelationship of input(s) to output(s). A variety of existing programs for typical HVAC and/or energy management situations are optionally available. 7 Bit password ing to provide access security is standard.

ELECTRICAL

Power	115 VAC 60Hz, 55 Watts max., AC/DC filtering
Protection	Circuit breaker

PHYSICAL

Size	17¾" (45cm) h., 19½" (49.5cm) w., 4" (10.2cm) d.
Weight	17 lbs. (approx.)
Shipping Weight	19 lbs. (approx.)
Enclosure	Wall-mounted metal enclosure with locking, hinged face panel. Terminal board with wiring trough knock-out at each end.

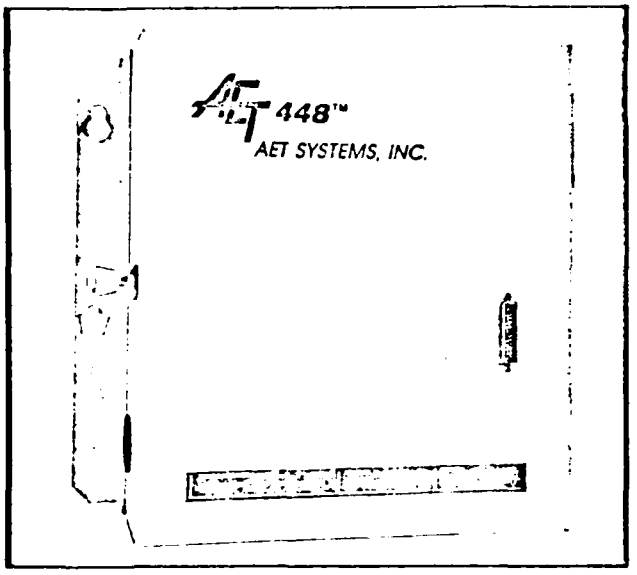
ENVIRONMENTAL

Ambient Operating Temperature	-18 to 49°C (0-120°F)
Humidity Range	5 to 95% (non-condensing)

OPERATIONAL

Inputs - Variable	16 Analog 0-5.1 VDC for temperature and other sensors. Accuracy to 20mV. Accuracy of 1.25mV available.
Inputs - Switch	8 On-Off sensed inputs with indicator LED's. No external power required.
Outputs	8 Internal SPDT solid state relays with indicator LED's. Provide 24 VDC, 3 amps max. for DDC or field relay control.
Inter-unit Status	4 Lines with indicator LED's for unit to unit signaling.
Programs	16 Independent user programs. 64 Lines per program @ 59 characters/line.
Data Logging	Total monitoring of inputs and outputs showing percentage of "On" time and average variables values over user-defined time intervals.
Clocking	Real time clock gives seconds, minutes, hours, days, day-to-month, year, and elapsed time.
Variable Input Bypass	8-Pole dipswitch permits user to isolate the system voltage and utilize sensing devices with external power supply.
Event Counters	4 Counters user programmable to any system event. Up to 65535 cycles per counter.
Battery Back-Up	Non-volatile RAM and time of day back-up for power losses up to 1 week.
Communications	RS232C port. ASCII keyboard compatibility. Selectable baud rate from 110 to 2400 bps at factory. 300 to 1200 bps field selectable. 20mA data loop standard.
Security	Dipswitch for user selectable 7 bit password.
Auto Dial/Auto Alarm	16 user defined alarm reports detailing "out of limits" or HVAC status to hard-wired or remote printer.

SPECIFICATIONS



AET 448™

ENERGY MANAGEMENT SYSTEM AND DIRECT DIGITAL CONTROLLER

DESCRIPTION

AET 448 is a microprocessor-based programmable controller designed for the management of mechanical equipment and energy loads, as well as control of specific process functions. It operates stand alone or as an intelligent peripheral in a central processor-based control and monitoring system.

FEATURES

- 4 Digital outputs
- 4 Digital inputs
- 8 Analog inputs
- Fail-safe output
- User programmable - up to 9 independent programs
- Calendar year programmability
- Data file maintained on inputs/outputs
- Telephone communications and diagnostics (standard)
- Complete memory back-up
- Security passwording
- Auto dial/alarm reporting (standard)
- Continuous internal diagnostics
- Remote indication of override switch positions
- Full math capability for DDC, PID and PWM
- Clear English labeling of inputs and outputs
- Automatic engineering unit conversion of analog values and digital inputs

OPTIONS

- Built-in 300/1200 baud modem
- Handheld or panel mounted programming key pad

TYPICAL APPLICATIONS

- Night & weekend setback
- Duty cycling
- Load shedding
- Optimized start-stop
- Enthalpy control
- Outdoor reset
- Temperature control
- Floating temperature control
- Sequenced start-up
- Holiday scheduling
- Chiller control
- Boiler control
- Pulse Width Modulation
- Emergency and alarming
- Power loss response

HARDWARE

AET 448 employs a Hitachi 6303 microprocessor with proprietary analog and digital I/O circuitry, including 16K of CMOS RAM and 16K (expandable to 40K) of UVE PROM. Screw terminal access is provided for 8 analog inputs, 4 discrete digital inputs, 4 SPST relay outputs. An RS232 port is standard. Pre-wired cables with connectors are provided for power supply, memory back-up and RS232 connections to the PC board.

Indication of override switch positions and user-programmed auto dial/alarm reports are available through the RS232 port.

AET SYSTEMS, INC.

SOFTWARE

Each AET 448 is furnished with a programming manual and user instructions based on the clear English AET CONTROL language. 35 Common mechanical terms are symbol-defined and factory-loaded into the unit's PROM along with +, −, ×, ÷, >, <, $\sqrt{\ }$, and = capability for ease of user programming. AET 448 can sustain 9 independent programs of 64 lines each @ 59 characters/line. Full algebraic capability for PID, PWM, and DDC is inherent in the software. User can program any desired interrelationship of input(s) to output(s). A variety of existing programs for typical HVAC and/or energy management situations are available.

ELECTRICAL

Power	115 VAC 60Hz, 85 watts max., AC/DC filtering
Protection	4/10A fuse

PHYSICAL

Size	12½" (31 6cm) h., 14" (35 6cm) w., 4" (10 2cm) d.
Weight	17 5 lbs (approx.)
Shipping Weight	19 5 lbs (approx.)
Enclosure	Wall-mounted enclosure with locking, hinged face panel. Terminal board with wiring trough, knock-out at each end and bottom.

ENVIRONMENTAL

Ambient Operating Temperature	− 18 to 49°C (0-120°F)
Humidity Range	5 to 95% (non-condensing)

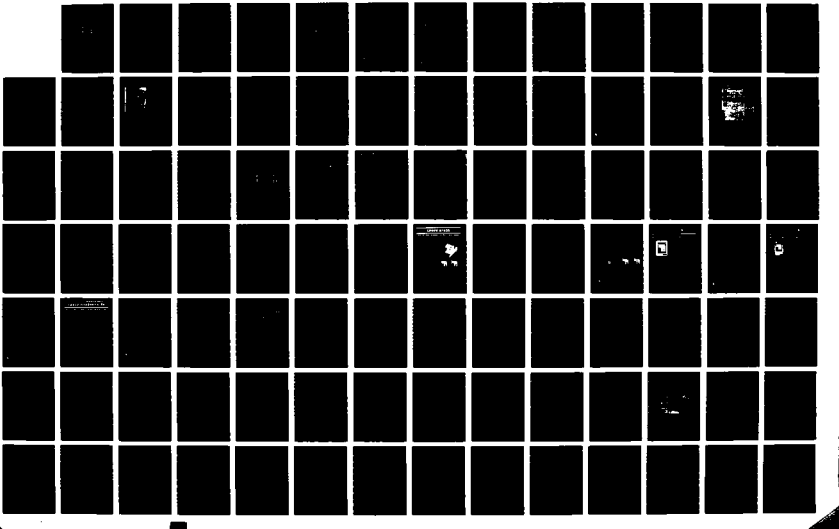
OPERATIONAL

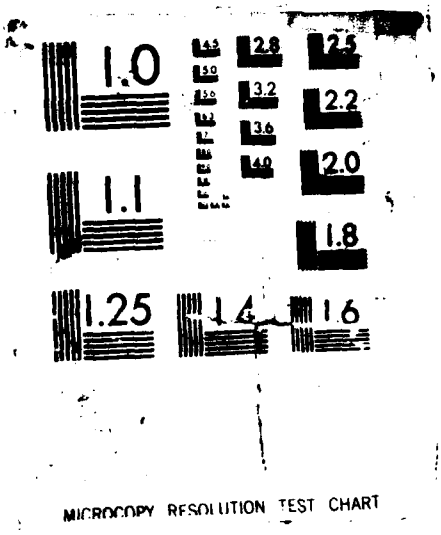
Inputs - Variable	8 Analog 0-5 1 VDC for temperature and other sensors Accuracy to 20mV.
Inputs - Switch	4 On-Off sensed inputs with indicator LED's. No external power required
Outputs	4 Internal SPST solid state relays with indicator LED's rated at 24 VDC, 3 amps max outputs for DDC or field relay control.
Programs	9 Independent user programs 64 Lines per program @ 59 characters/line.
Data Logging	Total monitoring of inputs and outputs showing percentage of "On" time and average variable values over user-defined time intervals.
Clocking	Real time clock gives seconds, minutes, hours, days, day-of-month, year, and elapsed time Automatic daylight savings adjustment.
Variable Input Bypass	8 Pole dipswitch permits user to isolate the system voltage and utilize sensing devices with external power supply
Capacitor Back-Up	Non-volatile RAM and time of day back-up for power losses up to 1 week, maintenance free.
Communications	RS232C port. ASCII keyboard compatibility Selectable baud rate from 300 to 9600 bps
Security	Two 5-character passwords
Auto Dial/ Auto Alarm	8 User-defined alarm reports detailing "out of limits" conditions, HVAC status and preventive maintenance procedures to hard wired or remote printer.
Fail-Safe Output	One internal normally closed fail-safe output rated at 24 VDC, 100 mA maximum for power loss or system failure notification

AMF PARAGON ELECTRIC CO.

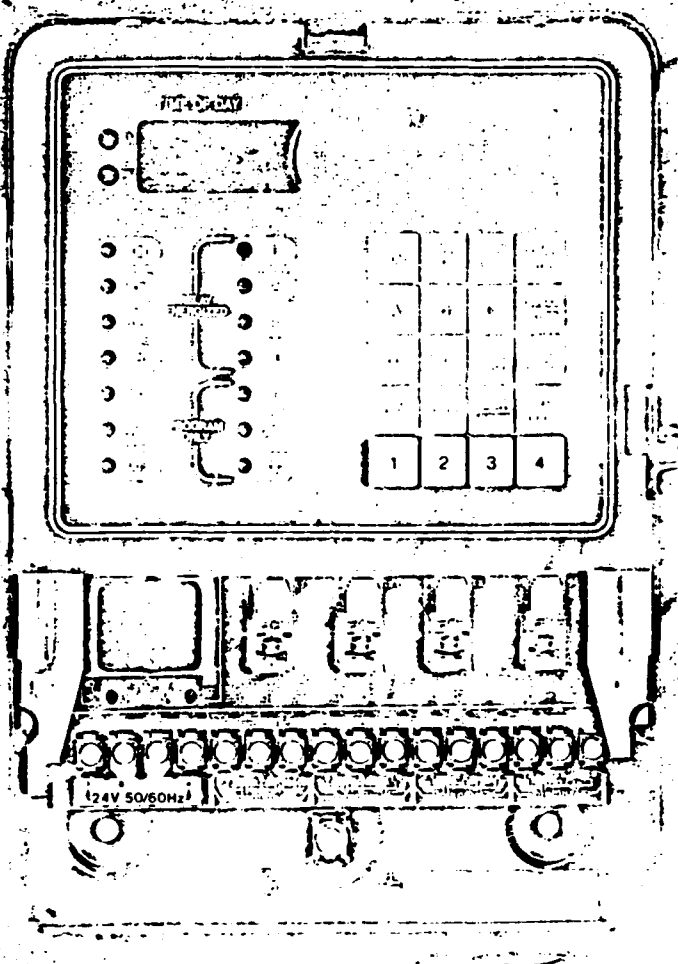
AD-A184 083 SURVEY STATE OF THE ART: ELECTRICAL LOAD MANAGEMENT TECHNIQUES AND EQUIPMENT(U) ENVIRO-MANAGEMENT AND RESEARCH INC SPRINGFIELD VA N KHOSLA 31 OCT 86 2/3

UNCLASSIFIED DAAK70-86-C-0035 F/G 10/2 NL





4-channel electronic controls
that make it easy to cut energy costs and
replace mechanical master clocks

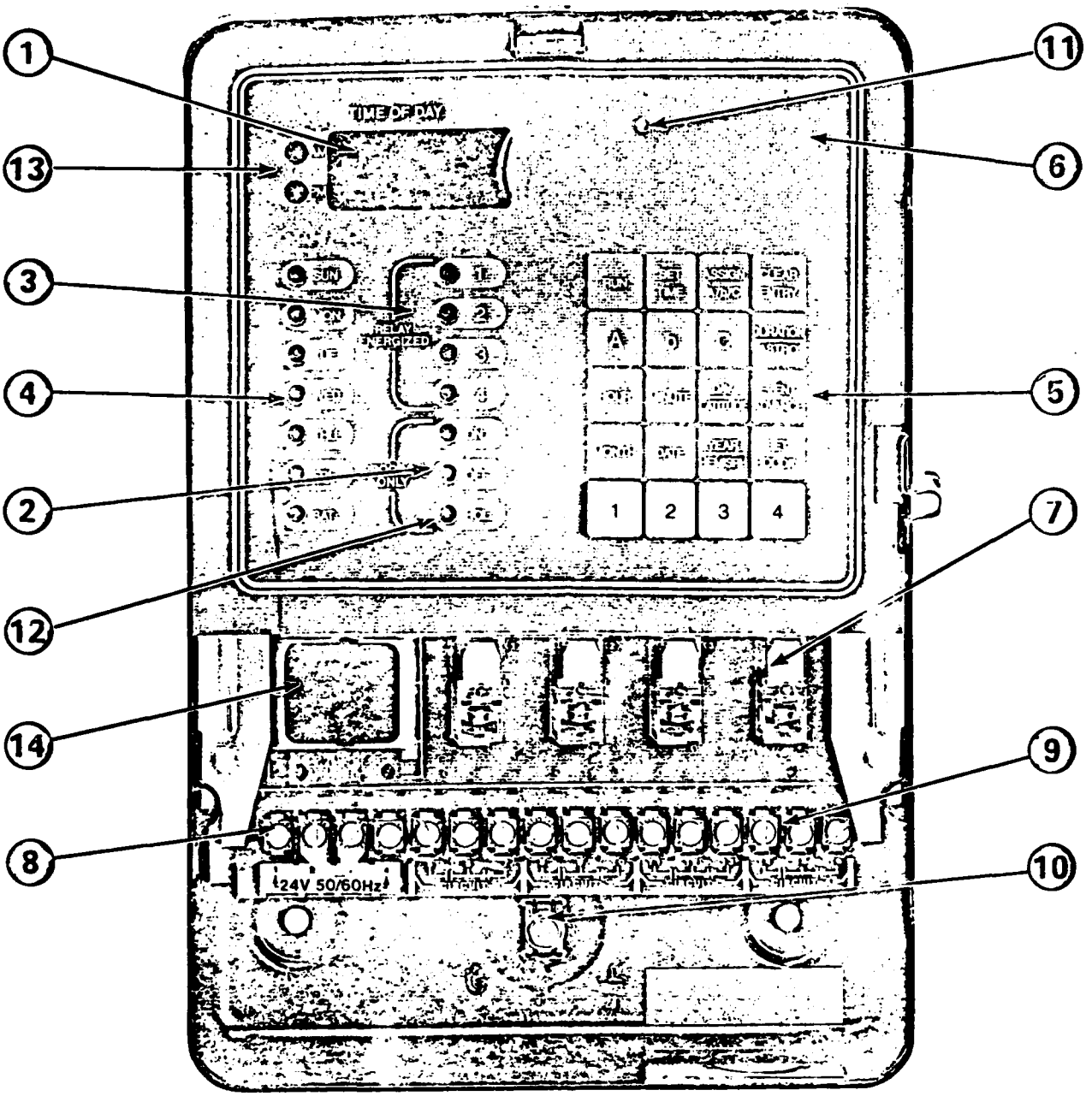


AMF

Paragon

PACESETTER IN ELECTRONIC CONTROLS

EC74 Programmable Time Controls



1. DIGITAL DISPLAY Indicates time-of-day and events being programmed or reviewed.
2. ON/OFF STATUS LEDS Show the event as either ON or OFF during programming or duty cycling.
3. CIRCUIT ENERGIZED LEDS Indicate status of the four output relays during normal operation. (Assumes common to N.O. wiring). During programming they show circuit being programmed.
4. DAY LEDS Indicate the current day of week or the day of week being programmed.
5. KEYBOARD Used to program, review schedule, and manually override relay outputs.
6. POWER OUTAGE BATTERY COMPARTMENT — Replaceable lithium battery provides a minimum of four months accumulated carry-over for both time and program during power outages. (Battery is behind face plate).
7. FOUR SPST OUTPUT RELAYS 10A resistive at 24 Vac or 120/240 Vac.
8. POWER INPUT 24V and 120/240V, 50/60 Hz self-adapting.
9. OUTPUT TERMINALS Connect relay outputs to loads.
10. SYSTEM GROUND Used for connection to systems ground.
11. RESET SWITCH Recessed switch to reset the control and clear program.
12. HOLIDAY LED Indicates holiday being programmed or reviewed.
13. AM/PM LEDS Show day status of an event or time-of-day.
14. TRANSFORMER Used for isolation on 24 Vac versions. On 120/240 Vac versions, transformer is used to step down Voltage to 24 Vac.

Paragon EC74 Programmable Time Controls

Paragon EC74 Series controls offer an electronic, microprocessor based alternative to electro-mechanical time clocks. These timers are designed with four independent channels which operate from a single time base and provide greater programming flexibility and accuracy.

The solid state design and internal logic of the EC74/192MA and EC74/120D controls expand programming capabilities for use with: energy management programs, heating/ventilating/air conditioning systems, indoor and outdoor lighting and security lighting. In addition, the EC74/192MA is ideally suited to control bells, synchronous wall clocks and latching relays.

The EC74/192MA and EC74/120D are offered in 24 Vac and 120/240 Vac versions.

Time-of-Day Scheduling

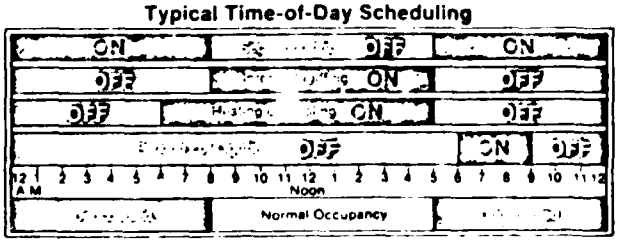
The EC74 Series controls provide time-of-day (TOD) scheduling which is the simplest method for cutting electrical use. Scheduling involves de-energizing indoor and outdoor lighting systems, heating, air conditioning, ventilating, process and many other electrical loads during unoccupied periods. The length of time a load is scheduled OFF and the power rating of that load are the keys to time-of-day savings.

Lighting and HVAC Scheduling

An indoor lighting circuit rated at 10 kilowatt (kW) and energized 24 hours per day consumes 240 kilowatt hours (kWh))10kW x 24 hr.) per day, 4 days per week. A time-based control is installed to shut lights OFF during unoccupied times from 5:00 p.m. to 7:00 a.m. or 14 hours per day. The resulting electrical savings would be 140 kWh per day or 36,400 kWh per year. With a typical electrical rate of 6 cents per kWh, annual savings of $2,184 would result.

This same procedure employed throughout a building or facility can result in tremendous reduction of electrical costs.

Typical Time-of-Day Scheduling

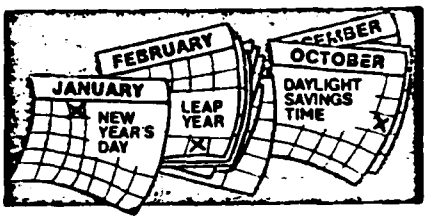


Holiday Programming

The EC74 has the capability for 32 single day holidays each year. For holiday periods or shut downs longer than a single day, up to 16 holiday durations can be programmed for 2 days to 11 months. The holiday program can be entered up to a year in advance. Each channel may have different holidays applied to it.

Daylight Savings Time

The appropriate dates are entered with the annual program, and the control automatically adjusts for daylight savings time when appropriate. No need to call a serviceman to reset clocks. Leap year correction automatically programmed.



Automatic Seasonal Adjustment

Circuit 1 of the EC74/192MA and 120D provides the ASTRO DIAL® feature. The ASTRO DIAL feature conserves energy by accurate control of parking lot lights, security lights, and outdoor signs. It will turn lights ON at dusk and OFF at dawn. Initial programming includes entering sunrise and sunset times, northern or southern hemisphere, and latitude. The control will then automatically adjust to seasonal changes in sunrise and sunset times without the cost of installing a photocontrol.

Electronic ASTRO DIAL®

Power Outage Carry-over

A minimum of 4 months of accumulated carry-over for time-of-day and program is provided by a lithium battery. When power is restored, circuits stagger and the control assumes the program mode of operation.

Manual Override

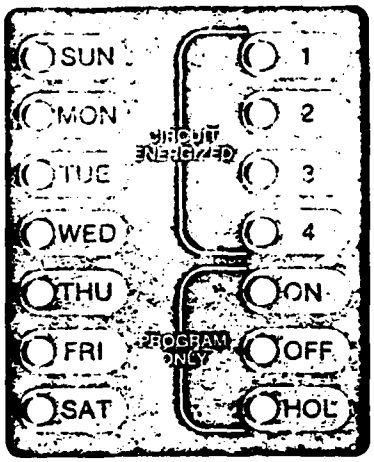
When temporary alterations to the program are needed, output relays may be energized or de-energized manually via the keyboard. The program override remains in effect until the next scheduled opposite event occurs or momentary output is initiated. The EC74 will then return to its programmed schedule.

EC74/120D Special Features

True 7-Day Time-of-Day Programming

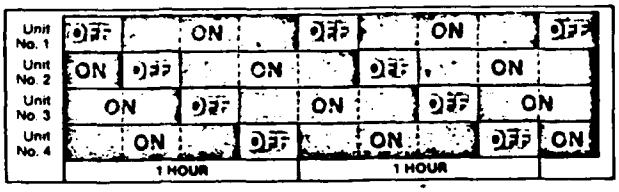
The EC74/120D features true 7-day programming capabilities. Each circuit can be independently programmed for each day of the week.

The EC74/120D has 30 ON/OFF events per channel for a total of 120 events.



Duty Cycle Program

Typical Time-Based Duty Cycling



The EC74/120D provides a duty cycle on all circuits with ON and OFF durations independently programmable from 1 to 99 minutes resulting in ON/OFF cycle lengths from 2 to 198 minutes for each circuit.

HVAC equipment typically has excess capacity for extreme outside temperature conditions and future growth. Subsequently, the equipment may be cycled ON and OFF on a time interval basis so that minimum operating time is required to maintain comfortable environmental conditions. This electrical energy management technique not only reduces demand peaks but may reduce total energy consumption for the equipment being cycled.

Four 20 kW air handling units that are cycled OFF for 15 minutes out of the hour could result in a reduction of 20 kW per hour demand or a 25% savings on HVAC system energy costs.

Timed Override

The EC74/120D features a timed override that can be programmed from 1 to 99 minutes of override time for each of the 4 circuits.

How to Specify

EC74/192 MA

Installer shall furnish and install AMF/Paragon EC74/192MA Programmable Time Control with 24V (120/240V), 50/60HZ self-adapting. The solid state 365-day time-based control shall have the capability of being programmed each day of the week. Up to 32 single day holidays or 16 holiday durations, with 11 month maximum duration length, can be programmed as well as daylight savings time changeover. The control has been leap year corrected to the year 2100 A.D. The control is to have ASTRO DIAL® feature. Keyboard shall provide access to all programming, program review, and circuit override. LED display shall display time-of-day with one minute resolution, day of week, and circuit status. The system shall control up to 192 events with 48 events available per circuit. Each output shall be programmable for maintained or momentary contact. Programming shall provide A, b, C or SKIP programs assignable to the days of the week and holiday. The A, b, and C programs of each output can contain up to 8 ONs and 8 OFFs or up to 15 momentary contact closures. Each circuit can be programmed with up to three different durations, programmable from 1 to 99 seconds to provide momentary contact closure. Outputs shall include 4 SPDT relays, contacts rated 10A resistive at 24V or 120/240V.

During power outages, control is to maintain program and time-of-day for a minimum of four months of accumulated power outages with a replaceable lithium battery.

EC74/120D

Installer shall furnish and install AMF Paragon EC74/120D Programmable Time Control with 24V (120/240V), 50/60Hz self-adapting. The solid state 365-day time-based control shall have the capability of being programmed each day of the week as well as daylight savings time changeover. The control will be leap year corrected to the year 2100 A.D. The control is to have duty cycle capability, timed override from 1 to 99 minutes and ASTRO DIAL® feature.

Keyboard shall provide access to all programming, program review, and circuit override. LED display shall display time-of-day with one minute resolution, day of week, and circuit status. The control shall have up to 120 ON and OFF events with 30 events per circuit. Outputs shall include 4 SPDT relays, contacts rated 10A resistive at 24V or 120/240V. During power outages, control is to maintain program and time-of-day for a minimum of 4 months of accumulated power outages with a replaceable lithium battery.

EC74 Series Programmable Time Controls

Specifications

Programming capabilities

1. 7-day programming
   — open scheduling—EC74/120D
   — 3 schedules (A, b, C)—EC74/192MA
2. 365-day calendar with automatic adjustments for daylight savings time and leap year
3. 32 holidays per year programmable by date
4. 16 holidays per channel with duration setting
5. 30 ON/OFF events per channel—EC74/120D
   16 ON/OFF events per program per channel—EC74/192MA
6. Duty cycling and repeat programming—EC74/120D
7. Momentary contact closure from 1-99 seconds—EC74/192MA
8. ASTRO DIAL® on channel 1
9. Manual override
10. Timed override from 1-99 minutes per channel—EC74/120D
11. 1 minute resolution for time-of-day and events

Electrical

1. **Power Requirements**
   24 Vac Model— 24V (+10-15%), 50/60 Hz, 10VA maximum
   120 Vac Model—120V (+10-15%), 50/60 Hz, 10VA maximum
   240 Vac Model—240V (+10-15%), 50/60 Hz, 10VA maximum
2. **Output**—4 SPDT output relays rated 10A resistive
   24 Vac Model—40VA pilot duty at 24 Vac
   120 Vac Model—200VA pilot duty at 100 Vac
   240 Vac Model—345VA pilot duty at 240 Vac
3. **Wiring**—Terminals can accommodate 14 to 24 AWG wire

Power Outage Carry-over

1. Program and time-of-day backup—4 months of accumulated carry-over by means of a replaceable lithium battery.
2. Following the power outage, circuits stagger ON and the control assumes the program mode of operation.

Accuracy

1. Time-of-Day Maintenance of time is as accurate as line frequency.
2. Programming—Time-of-day and ON and OFF program time resolution is one minute.

Applications

The EC74 controls are applicable to facilities such as retail and convenience stores, schools, offices, industrial buildings, churches, etc.

Typical loads

Controllable loads are: heating/ventilating/air conditioning systems, indoor and outdoor lighting, security systems, bells, synchronous wall clocks, latching relays.

Physical

1. Enclosure Type—NEMA 1—Metal housing with left hinged, locking, front cover access.
2. Mounting—Vertical mounting
3. Finish—Dark brown enamel.
4. Dimensions—
   Width 7.4 in (18.7 cm)
   Height 10.9 in (27.6 cm)
   Depth 3.0 in (7.7 cm)
5. Weight—Approx. 5.25 lb. (2.4 kg)
6. Shipping Weight—Approx. 6.0 lb (2.8 kg)

Environmental

1. Temperature
   +32°F to +122°F (0°C to +50°C)
2. Humidity
   10-95% RH (non-condensing)

Model Selection Chart

MODEL	VOLTAGE	FUNCTIONS
EC74/192MA 24	24 Vac	Time-of-day scheduling Adjustable momentary contact capability plus ASTRO DIAL
EC74/192MA 120/240	120/240 Vac	
EC74/120D 24	24 Vac	Time-of-day scheduling duty cycling plus ASTRO DIAL
EC74/120D 120/240	120/240 Vac	

AMF
Paragon

A WORLD LEADER IN TIME CONTROLS

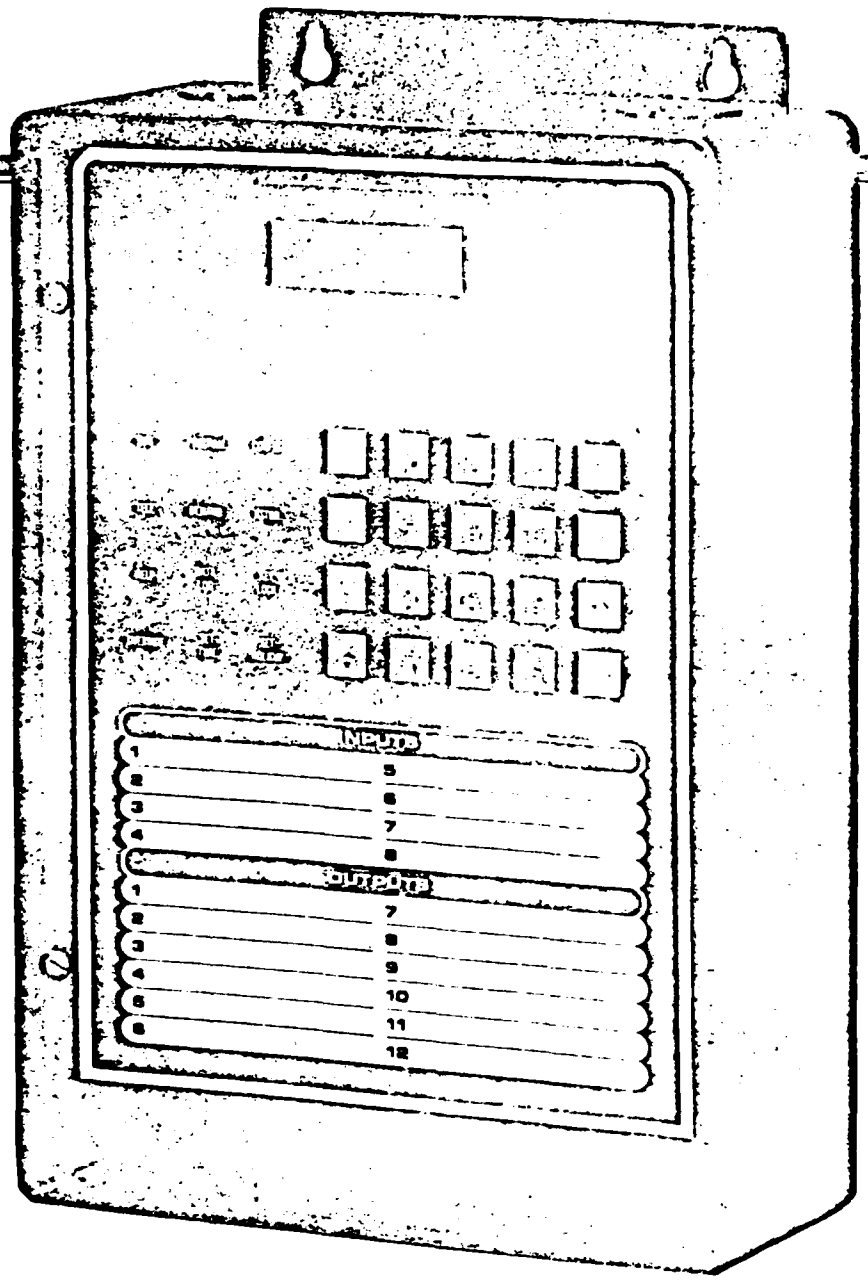
PARAGON ELECTRIC COMPANY INC.
606 Parkway Blvd., Two Rivers, WI 54241 USA 414/793-1161

INTERNATIONAL SALES OFFICE:
Two Rivers, WI 54241 U.S.A.
Cable: PECO Telex 26-3450 AMFPARA TWOR

IN CANADA: PARAGON ELECTRIC
Division of AMF CANADA LIMITED
52 Royal Road, Guelph, ONT N1H 7H1 519/822-1576

PARAGON EC128

Energy Monitoring and Control System



The features of a large EM System in a smaller, affordable control.

- 12 Loads
- 8 Analog Inputs
- Meter Input
- Demand Control
- Optimized Start and Stop
- Adaptive Duty Cycling
- Remote Communications
- Astro-Dial™
- Dial Out
- 365-day Calendar
- Holiday Scheduling
- Security Lockout

PARAGON

PACESETTER IN ELECTRONIC CONTROLS

PARAGON EC128

System features and applications

The Paragon EC128 Energy Monitoring and Control System has the features of a big energy management system in a smaller, affordable control. It is specifically designed for small to medium sized buildings such as supermarkets, department stores, schools, home centers, banks, offices and auto dealerships.

With 12 loads and 8 analog inputs, the EC128 fills the gap between multi-channel controls and larger energy management systems. It is competitively priced to provide a quick payback by uitilizing demand control, adaptive duty cycling, optimized start and stop, daylight savings time adjustment, meter input and Astro-Dial™.

With the remote communications module, all programming, control and data of the EC128 may be handled from a remote computer. In addition to remote communications capabilities, the EC128 can load and store the entire controller memory and programming into its Memory Storage Module. This module allows the copy of the programming to be reloaded into the controller at any time and by designing this module with erasable and reprogrammable memory, the program is stored indefinitely without an external power supply.

Traditional Paragon reliability and technical support are matched with state-of-the-art capabilities to make the EC128 Energy Monitoring and Control System a controller to be reckoned with.

Time of Day Scheduling

75 on and off events for single day or multiple days and for any number of outputs to give precise load control to switch equipment off during periods of non-use.

Duty Cycling—Time based or adaptive

Duty cycling can reduce energy demand and equipment wear by cycling equipment on and off. By adding sensor control the duty cycling rate can be adapted or automatically varied. Comfort can be maintained along with the reduction of KW demand. When utilizing the staggered option start-up, KW can also be reduced when more than one load is assigned to the duty cycling program.

Sensor Control

The EC128 may control HVAC equipment directly by monitoring temperature or KW, comparing the value(s) to a programmed setpoint(s) and taking proper control action. This eliminates tampering of thermostats and allows efficient temperature and equipment control.

Variable Sensor Control—Reset

Variable sensor control involves a unique 'master/slave' arrangement where the value of one sensor interacts and modifies the conrol range for a second sensor. Outdoor temperature modifying boiler tank temperature is an example of an application for variable sensor control.

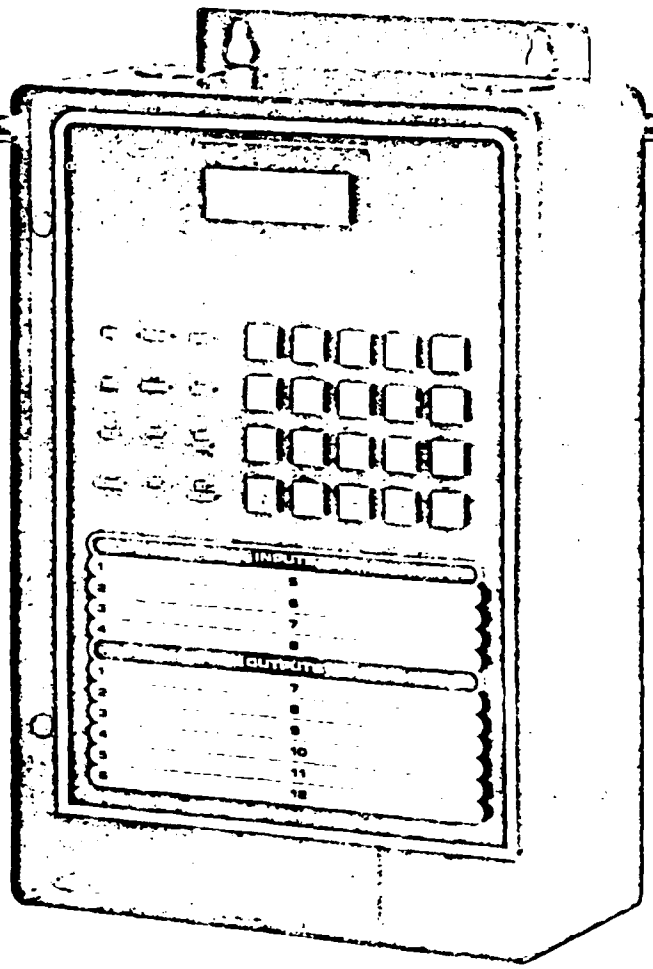
Demand Scheduling

Demand control is shutting off or shedding noncritical loads during peak demand periods to reduce KW demand charges. The EC128 monitors KW via its pulse input port which receives pulses from a remote power meter.

Astro-Dial™

The Astro-Dial feature allows you to control outdoor and security lighting loads in conjunction with the seasonal changes of the rising and setting of the sun without the need of a photo cell. By programming the date and your local sunrise and sunset times, the EC128 can 'track' the sun and allow loads to be on only when the sun is down.

PARAGON EC128



Holidays

Unlike many other energy management controllers, the EC128 has four different holiday schedules. This allows programming of half-days, full days or special holidays. Up to 32 holiday durations are available, each lasting up to 366 days. The flexibility of this feature is evident in a typical school application where there could be an unscheduled half or full day holiday, as well as the regularly scheduled holidays.

User Configuration Setting

Allowing configuration of the EC128 to your specific needs is one of the many user friendly design standards found in this controller. Some things left for your configuration include: relay logic (reversed or normal); maintained or momentary ouptputs, clock format (12 or 24 hour); temperature format (Farenheit or Celsius); input type (digital or analog); adjustable stagger-up rate from 0 to 9 seconds; and minimum and maximum on and off duartions for each load.

Performance Log

The EC128 is designed with half of the memory allocated to data storage. By recording such items as temperature history, demand history, and load run times, a performance profile can be developed to demonstrate the system's ability to efficiently control equipment and costs.

Security Lockout

An entry code may be programmed into the EC128 to allow restricted access when and where necessary. This prevents changing or possible erasure of programs by unauthorized persons.

Remote Communications and Dial Out

The remote communications module provides for interfacing with the IBM PC, or compatibles, which facilitates all programming and operation of the EC128 from a remote site. It is possible to program two telephone numbers into the EC128 which will be automatically dialed in the event of an alarm situation or at a specified time of day. You have complete access to the EC128 providing more efficient control and reducing the need for site visits.

Accessories and Options

Sensors

Indoor Temperature Sensor Model TS2-E
32°F (0° C) to 122°F (50° C)

Outdoor Temperature Sensor Model TS2
-40°F (-40° C) to 140°F (60° C)

Remote Communications CM-1

Performs interfacing function for Hayes compatible modems. Enhances data collection feature for EC128 and allows remote programming, monitoring, and alarm dial out capability. Transfers at 300 or 1200 baud rates depending on baud rate or interfacing computer modem.

Memory MSM-1

This memory storage module allows permanent memory storage in E²PROM. Connects to remote communications port and is guaranteed that it can be erased and reprogrammed a minimum of 100 times. The memory module can upload or download programmed data to or from the EC128.

PARAGON EC128

Applications Summary and Specifications

Applications Summary

Most buildings, no matter what the size, have many of the same basic needs – heating, cooling, ventilation, indoor, outdoor and security lighting. The Paragon EC128 Energy Monitoring and Control System is designed for small to medium sized buildings and takes advantage of a wide selection of the most current energy cost management techniques.

APPLICATION	TIME OF DAY	DUTY CYCLE	ADAPTIVE DUTY CYCLE	SENSOR CONTROL	VARIABLE SENSOR CONTROL	OPTIMIZE START/ STOP	DEMAND CONTROL	MOMENTARY	ASTRO DIAL	REMOTE COMMUNICATIONS
LIGHTING										
Indoor	•						•	•	•	
Outdoor	•						•	•	•	
Security	•						•	•	•	
HVAC										
Unit Heaters, Boilers, Roof Tops	•	•	•	•	•	•	•			
Heat Pumps, Cooling Towers	•	•	•	•	•	•	•			
Wall Units, Fans, Dampers	•	•	•	•	•	•	•			
GENERAL										
Motors	•	•					•			
Clocks	•							•		
Bells	•							•		
Horns	•							•		
PERFORMANCE MONITORING										
Temperature History										•
Demand Profiles										•
Load Run Time										•
Output Status										•
Report Generation / Dial Out	•			•			•			•

Specifications

Electrical

Input Power: 24 Vac (+ 10% – 15%), 50 or 60 Hz (self selecting)
Maximum Power Consumption: 10 Va
Output Relay Contacts: 12 SPDT rated at 10A resistive
Input Analog Temperature Sensors: Up to 8
Temperature Range: – 40° (– 40°C) to 215°F (102°C)
Demand Input: X pulse – maximum input rate

Carryover

A minimum of 4 months memory retention provided by a primary lithium battery.

Environmental

Operating 32°F (0°C) to 122°F (50° C)
Storage 0°F (-20°C) to 140°F (60° C)
Relative Humidity: 10 – 90% RH (noncondensing)

Physical

Dimensions: 8.75" W c 13.25" H x 4.24" D
(22.22 cm x 33.65 cm x 10.80 cm)
Enclosure: Nema 1 metal housing with removable, left hinged, locking door access. Transparent window in door. Conduit knockouts for top, bottom, and side entrance.

PARAGON

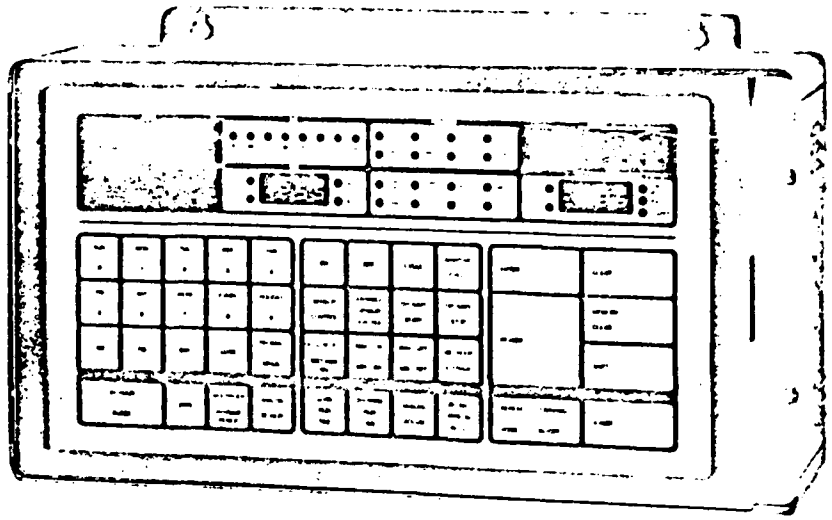
PARAGON ELECTRIC COMPANY, INC.
606 Parkway Blvd., P.O. Box 28
Two Rivers, Wisconsin 54241 U.S.A.
(414) 793-1161 TELEX: 26-3450

EC732 Energy Management System Features

- 4 to 32 outputs
- Time-of-day scheduling
- Time-based or staggered duty cycling
- Keyboard programming and override
- 4-digit access code to restrict programming access
- Programmable time, day, date and year
- 12 hour clock with AM/PM indication
- Daylight savings time and leap year automatically calculated
- 16 holiday durations from 1 to 127 days each programmable one year in advance
- Battery powered carryover to maintain program memory and time during power outages for up to 7 days
- Reverse relay logic programming

Optional Features

- 40 to 16 analog inputs
- Adaptive duty cycling based on temperature or electrical demand
- Analog control and variable analog control of HVAC equipment
- Optimized start/stop
- Demand Control to reduce kW demand charges
- Data gathering and logging of analog inputs, outputs, and overrides
- Remote Communication allowing EC732 to interact with a remote computer
- Local Printer Interfacing to obtain a printout of data stored in the EC732
- Voice prompting for programming assistance and program review



The AMF/Paragon EC732 Energy Management System is a modular microprocessor based system which provides control of 4 to 32 different loads expandable with 4 and 8 channel output relay modules. Analog inputs are expandable from 0 to 16 using 4 and 8 point input modules. Other optional modules include: override, demand, voice communication, remote communication, dial-out, and local printer interface.

The control is programmable using a membrane-type operator panel mounted within a lockable enclosure. The enclosure has a removable door with a window for viewing the LED displays when the enclosure is locked. A 4 digit access code entered through the keypad allows program review and data analysis while restricting program modification to authorized personnel only. Optional voice prompting provides programming assistance and audio review of programs.

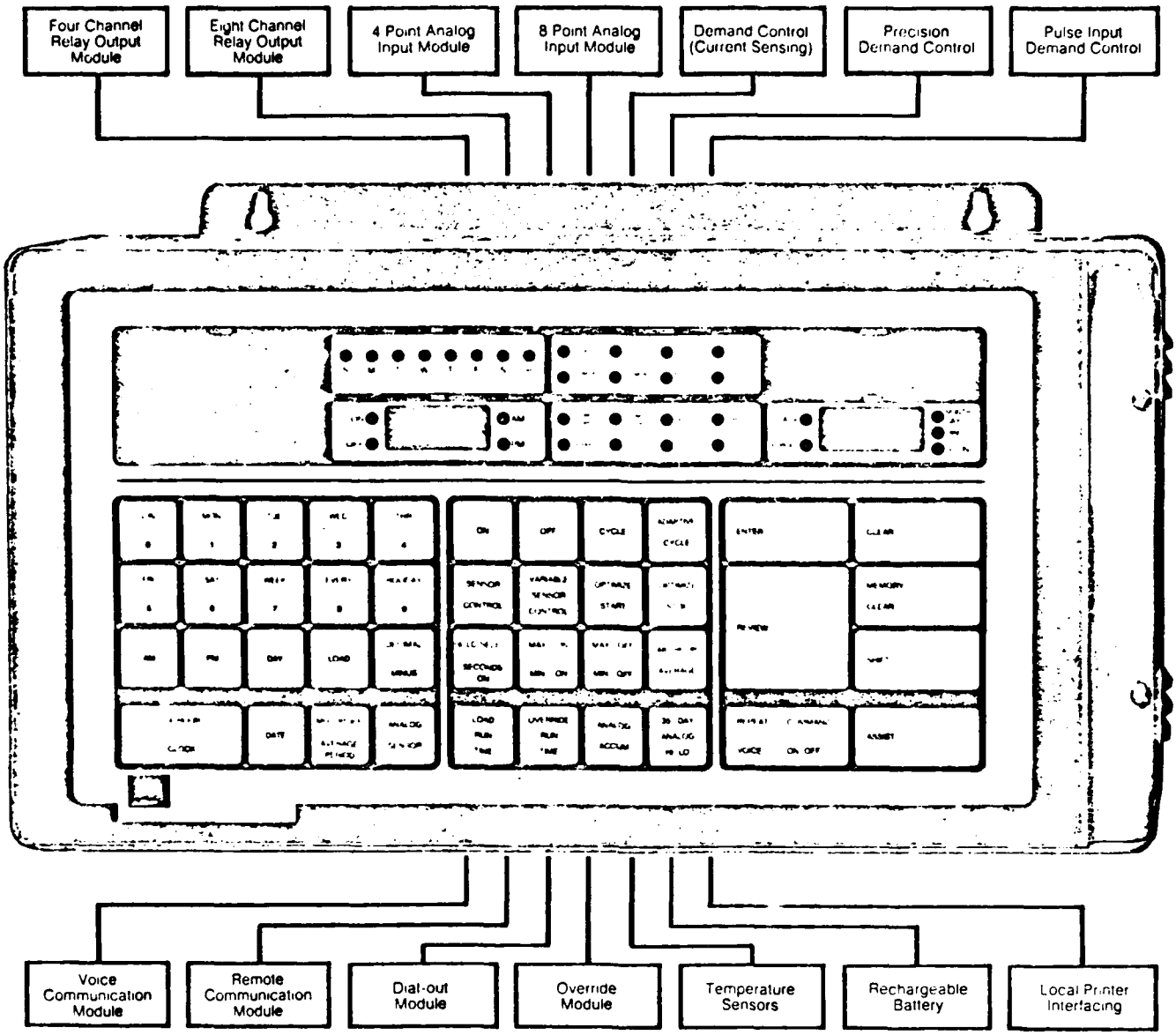
The EC732 controller operates using a 12 hour clock with AM/PM indication and the Gregorian Calendar. Leap year and daylight savings time are automatically calculated and implemented.

Program and time are maintained during power outages for up to 7 days with a rechargeable battery. After power is resumed, controller will update all outputs sequentially in 1 second intervals.

AMF Paragon

EC732 Energy Management System Data Sheet

EC732 Energy Management System



Time-Of-Day Scheduling

Time-of-day scheduling reduces electrical consumption and equipment wear by programming loads to switch OFF during hours of nonuse.

Each output can be programmed to the minute with a separate, independent program for eight day types, Sunday through Saturday, and holidays. Up to 30 ON or OFF set points for time-of-day scheduling are available for each day. Up to 32 loads can be assigned to a set point.

The system may be programmed for up to sixteen (16) holidays by date, automatically using a separate set of operator defined holiday programs for each load. Holidays can be programmed up to one year in advance with durations of 1 to 127 days.

To accommodate unscheduled occupancy periods, and load(s) may be programmed with a temporary ON or OFF up to one week in advance. Temporary programs are automatically cleared after use.

Any load may be overriden to an ON or OFF state from the keyboard. With the addition of an optional ORM-8 override module(s), up to 32 independent loads may be overriden from a remote contact(s) closure. The module also provides accumulation of hours and minutes in the override mode for each output.

Duty Cycling

Duty cycling reduces kW demand and kWh electrical consumption by cycling equipment ON and OFF so minimum operating time is used to maintain comfortable environmental conditions.

ON and OFF duration lengths for each load are individually definable from 0 to 127 minutes, with one minute resolution.

The staggered or rotating duty cycling feature automatically assigns loads to an internal schedule that aligns ON and OFF times in rotation to minimize electrical kW demand.

Adaptive or temperature compensated duty cycling automatically adjusts the ON and OFF durations in accordance with indoor temperature, outdoor temperature, or electrical demand.

When duty cycling is combined with analog control, a high or low temperature set point may override a duty cycle program.

Analog and Variable Analog Control

The EC732 may control HVAC equipment directly by monitoring temperature, humidity, kW, etc., comparing the value(s) to a programmed set point(s) and taking proper control action. Up to 16 analog inputs (two IPM-8 modules) are available for this analog control function.

Variable analog control involves a unique "master/slave" arrangement where the high and low setpont of any analog input controlling a load is linearly varied in response to a second analog input. This function is utilized for energy saving outdoor reset, boiler and chiller optimization functions.

Optimized Start/Stop

Optimized start reduces heating/cooling energy consumption by delaying warm-up/cool-down to the last possible minute before occupancy. Optimized stop reduces energy consumption by shutting off heating/cooling loads prior to end of occupancy without loss of comfort.

The optimized start and stop times are based on outdoor temperature, indoor temperature, heating/cooling thermal efficiency factors, building loss factors, occupancy temperature setpoint and history.

The optimized start and/or stop programs are self-adapting to the building requiring no adjustments and may be utilized independently. Non-adaptive start/stop may be programmed.

Demand Control

Demand control is shutting OFF (shedding) noncritical loads during peak demand periods to reduce kW demand charges.

The system utilizes a PDM-3 power demand module to monitor kW demand directly from a pulse-generating utility demand meter. If pulses are not available, a PDM-2 watt transducer and CT-2000 current transformers or a PDM-1 power demand module and CT-300 current transformers are required to monitor building demand. A PDM-1, 2, or 3 output is connected to one analog input.

Maximum and minimum ON and OFF times are assignable to each load for environmental (comfort) purposes and equipment protection.

Voice Prompting

The EC732 assist function provides step-by-step programming assistance using voice synthesis with the VCM and OMM-1 modules. Program review, error messages, and power failures are indicated verbally.

Fail-Safe Connections

The EC732 controlled loads will remain in the powered condition if power to the controller is interrupted. This requires wiring to the normally closed contacts of the respective load output relays. If desired, the reversed logic can be accomplished by jumper cuts on the keyboard panel.

Data Gathering and Logging

Data logging functions provide information necessary for determining energy savings, tracking building system performance and "fine tuning" the system.

- Accumulated consumption (kWh or other) on all 16 analog inputs.
- Records the maximum or minimum readings, temperature or demand on the first 8 analog inputs.
- Records 15 minute average analog reading, temperature or kW on the first 2 analogs for the past 48 hours.
- Records ON time of each output.
- Records override time of each output when optional override module is used.
- Continuous scan of analog input values are displayed.

Local Printer Interfacing

A printout of data logging and system status reports are obtained with the RCM communication module, OMM-2 memory module, and a local 80 column serial printer.

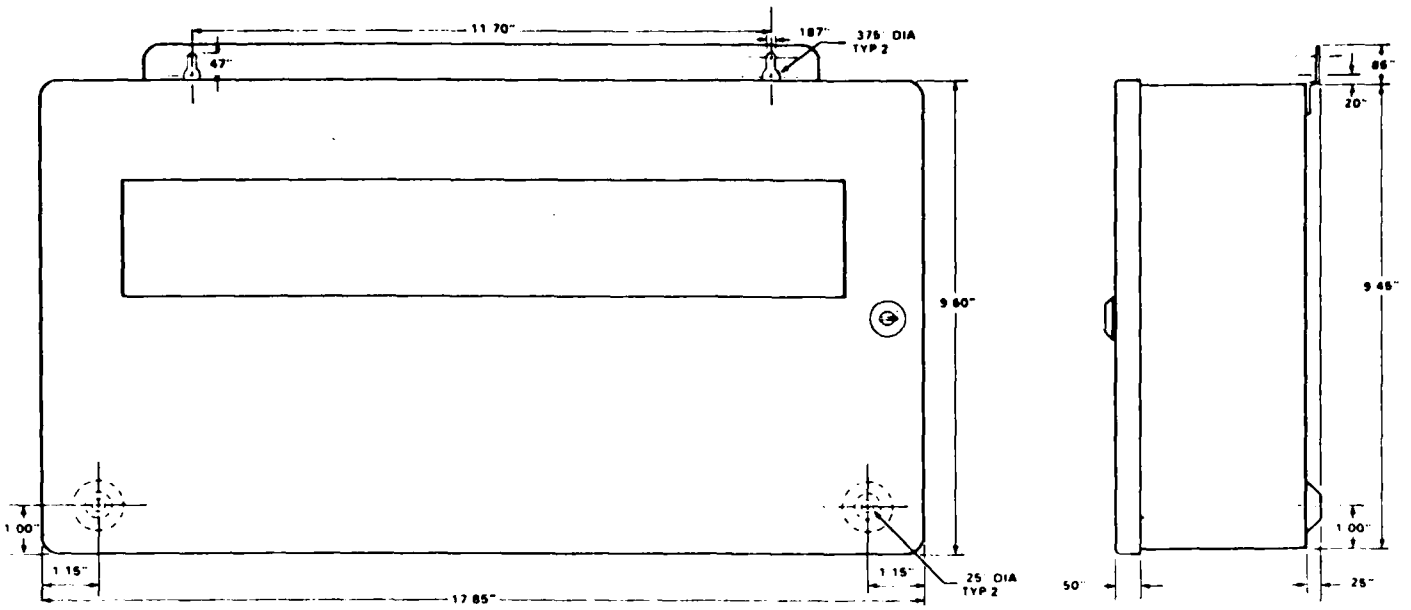
Remote Communication

The EC732 remote communication auto-answer options allow programming, data gathering, and interrogation from a remote location without travel to the site. An auto-dial option allows the EC732 to call a remote monitoring computer to report that an analog input set point has been exceeded.

Remote communication modules with modem (Model RCM-1) and without modem (Model RCM) may be connected to local or remote computer via voice-grade telephone lines. Auto-answer software is available for Apple II, II+, and IIe computers, TRS-80 Model III and IV computers, and IBM Personal Computer. Alarm auto-dial software is presently available for Apple II, II+, IIe computers.

The RCM or RCM-1 communication modules and software provide the ability to:

- Remotely display and/or modify all data that may be entered at the EC732 operator panel.
- Display all status available in easy-to-read formatted reports.
- Report the current days temperature, demand and consumption data.
- Report load status.
- Report accumulated ON time and override time for each output channel.
- Report analog data for every 15 minute average of the previous 48 hours on the first 2 analogs.
- Transfer and restore all programs.
- Report up to a 35-day history of daily high or low temperatures, high or low demand, time that high or low temperature and/or demand occurred, and kWh consumption of all connected analog inputs.
- Transfer report data to a printed format by using a computer and printer.
- Dial a remote telephone number if an analog is exceeded or upon a contact(s) closure.
- Assign special access code(s) to ensure security and allow only authorized personnel to program, interrogate, or modify the control activities.



Specifictions and Dimensions

Electrical

Input Power: 24 Vac (± 10%), 50 or 60 Hz
Maximum Power Consumption: 24 W
Output Relay Contacts: SPDT rated 5 A resistive at 24 Vac
Input for Analog Temperature Sensors: Up to 16
Temperature Range: -20°F (-29°C) to +200°F (93°C)
Voltage: 2.443 V at -20°F, 3.665 V at 200°F
Input for Optional Override Module: dry contact(s)
Carryover — 7 days of memory retention provided by rechargeable gel-cell.

Environment

Temperature: Operating 0°F (-18°C) to +120°F (49°C)
Storage -40°F to +150°F (65°C)
Relative Humidity: 0-90% non-condensing

Physical

Dimensions: 17.85" W × 10.3" H × 4" D (45 cm × 26 cm × 10 cm)
Weight: Approximately 15 lbs. (6.8 kg)
Enclosure: NEMA 1 metal housing with removable locking door and panel. Transparent window in door. Conduit knockouts for bottom, side, and top entrance.
Mounting: Vertical
Finish: Nitro-blue enamel

AMF Paragon

PARAGON ELECTRIC COMPANY, INC.
606 Parkway Blvd., P.O. Box, Two Rivers, Wisconsin 54241 U.S.A.

INTERNATIONAL SALES OFFICE: Two Rivers, Wisconsin 54241 U.S.A.
Cable. PECO Telex: 26-3450 PARAGON TWOR

IN CANADA. PARAGON ELECTRIC, P.O. Box 3620, Guelph, Ontario N1H 7H1, Division of AMF CANADA LIMITED

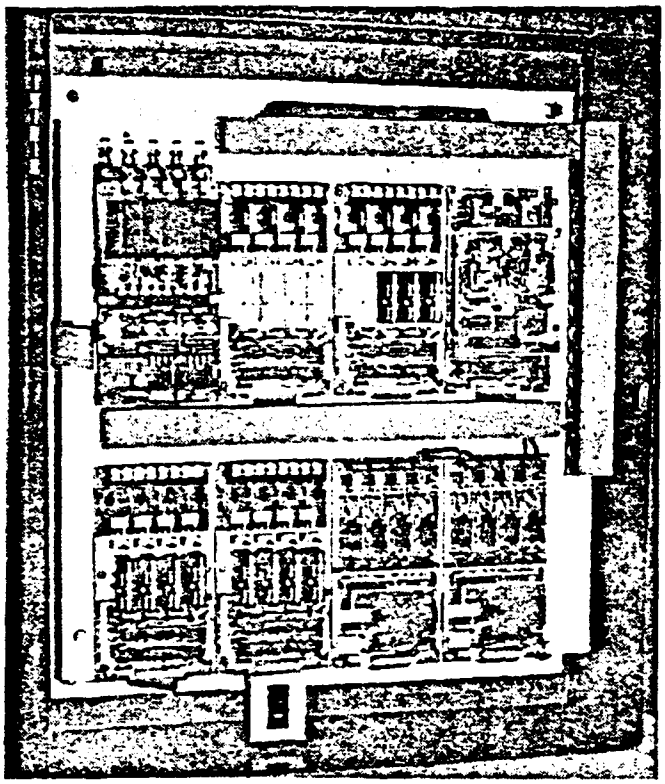
Bulletin #2122-M
Printed in U.S.A.

PACESETTER IN ELECTRONIC CONTROLS

ADVANCED MICRO SYSTEMS CORPORATION

ADVANCED MICRO SYSTEMS Corporation
9076 North Deerbrook Trail Milwaukee, Wisconsin 53223

PRODUCT DATA
VANGUARD™ RIM
(REMOTE INTERFACE MODULE)



VANGUARD RIM
(Remote Interface Module)

The RIM is an intelligent, standalone controller that monitors input points and performs DDC (direct digital control) of output points. A RIM may accommodate up to 16 or 32 installed I/O points within a standard database of 256 points and 16 meters. As a Building Automation System the RIM performs HVAC, lighting and process control, energy management, fire, security, smoke purging, secured access and data acquisition. A VANGUARD system can be a single RIM or a Local Area Network with multiple RIMs and Workstations configured to build a system of any size to accommodate the user.

Powerful Functions

The Building Automation functions in a RIM are managed by an extensive library of standard programs that perform: operator interface, direct digital control of points, metering, time management including 365 programmable holidays, PIDs, multiple point digital interlocking and calculated points, time-of-day and cycling control, runtime performance logging for control optimization and preventive maintenance. Control software is also supported by adaptive parameter reset (optimization) and extensive parameter scheduling. Scheduling allows parameters to be automatically changed on a daily, weekly or yearly basis. Data reporting can be done on a change-of-state basis, or on a daily or weekly schedule. Trend reports allow point and meter data to be accumulated daily or low, average, and high daily data values can be accumulated monthly for each day of the month. Each report is set up to collect data on it's own group of points or meters and operate on a sample period of one minute resolution.

User Memory

All programs are stored in permanent memory in each RIM and all user programming is stored in reprogrammable, permanent memory which is expandable to 64K bytes per RIM. Battery back-up is not required to protect memory data during power failure. Restart is automatic, without operator intervention or the need for reloading from floppy disc or cassette tape. A real-time clock is provided with battery back-up providing one year continuous power failure protection. User programming can copied to/from a Workstation and a RIM for additional backup.

Input/Output Modules

Inputs and outputs to the RIM are handled by Point Modules. PMs provide 4 channels of I/O of the same point type. The SA-16 RIM will

support 4 PMs and the SA-32 RIM will support 8 PMs. PM interfacing includes: voltage, current, frequency, digital, and pneumatic inputs and voltage, current, digital, PWM and pneumatic outputs. The PMs can be intermixed in any combination in a RIM. All output PMs include full-range, manual override controls for each channel.

LAN Interface

In the Local Area Network (LAN), each RIM controls it's own access to the network to share data and resources with other RIMs or Workstations on a real-time event or as needed basis. Because the network is controlled by each RIM or Workstation, there is no requirement of a central, head-end computer. The RIM functions in the LAN with any number of Workstations for multistation monitoring. The RIM supports optional plug in modules to accommodate installation on other LANs such as MAP™, Ethernet™, Token-Ring™.

Modem Interface

The optional modem interface allows RIMs to dial-up or answer calls from remote Workstations over telephone lines. The interface supports standard 212A, 1200 baud, auto dial/auto answer modems. An additional modem option incorporates the National Bureau of Standards Data Encryption Standard for all transmissions for maximum system security.

Operator Interface

The RIM supports a portable Vanguard terminal interface to provide a user local access to RIM data and programming. The portable terminal can be mounted on the RIM or located up to 1000 feet away. In a LAN system, Vanguard Workstations provide a network based operator interface to the RIM which supports multi-user access to RIM data and programming. A single user network interface is provided by the optional modem interface. The modem interface allows RIMs to be programmed or monitored from remote Workstation locations.

Printer Interface

Optional printer interface supports 80 column printouts at character rates in excess of 600 CPS.

RIM SPECIFICATIONS

Enclosure: NEMA Type 1
SA-16 24"H x 16"W x 7"D
SA-32 24"H x 20"W x 7"D
NEMA Type 4 & 12 available

Power: 120 V +- 10%, 1A max
Operating Temp.: 35-105°F, 0-40°C
Humidity: 0-95% RH (non-condensing)

LAN Communication Link: Single shielded, twisted pair cable, 18-22 gauge. RIMs and Workstations are connected in a daisy chain fashion to simplify installation and expansion. Protection against voltage transients to the communications trunk is integral to the RIM and Workstation.

Trademarks: MAP - General Motors, Ethernet - Xerox, Token-Ring - IBM

ADVANCED MICRO SYSTEMS Corporation
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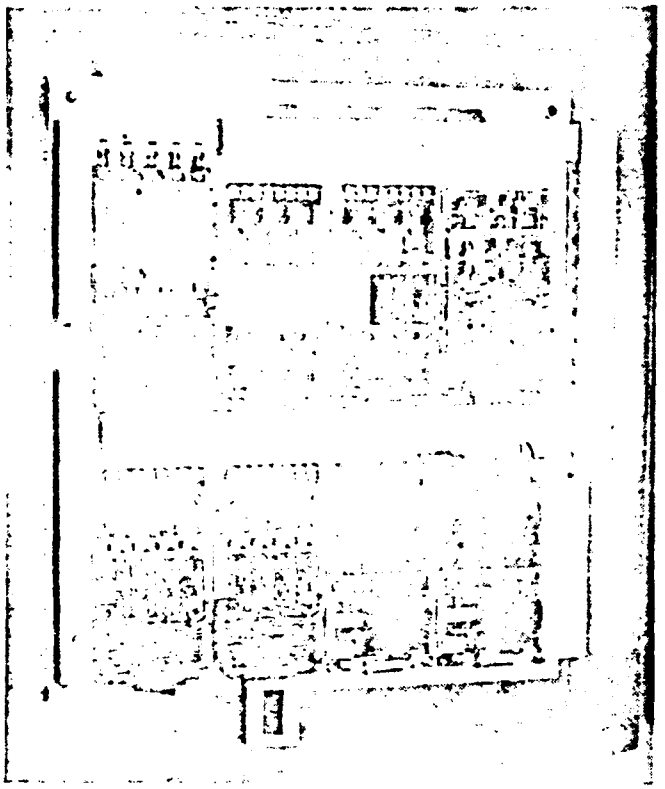

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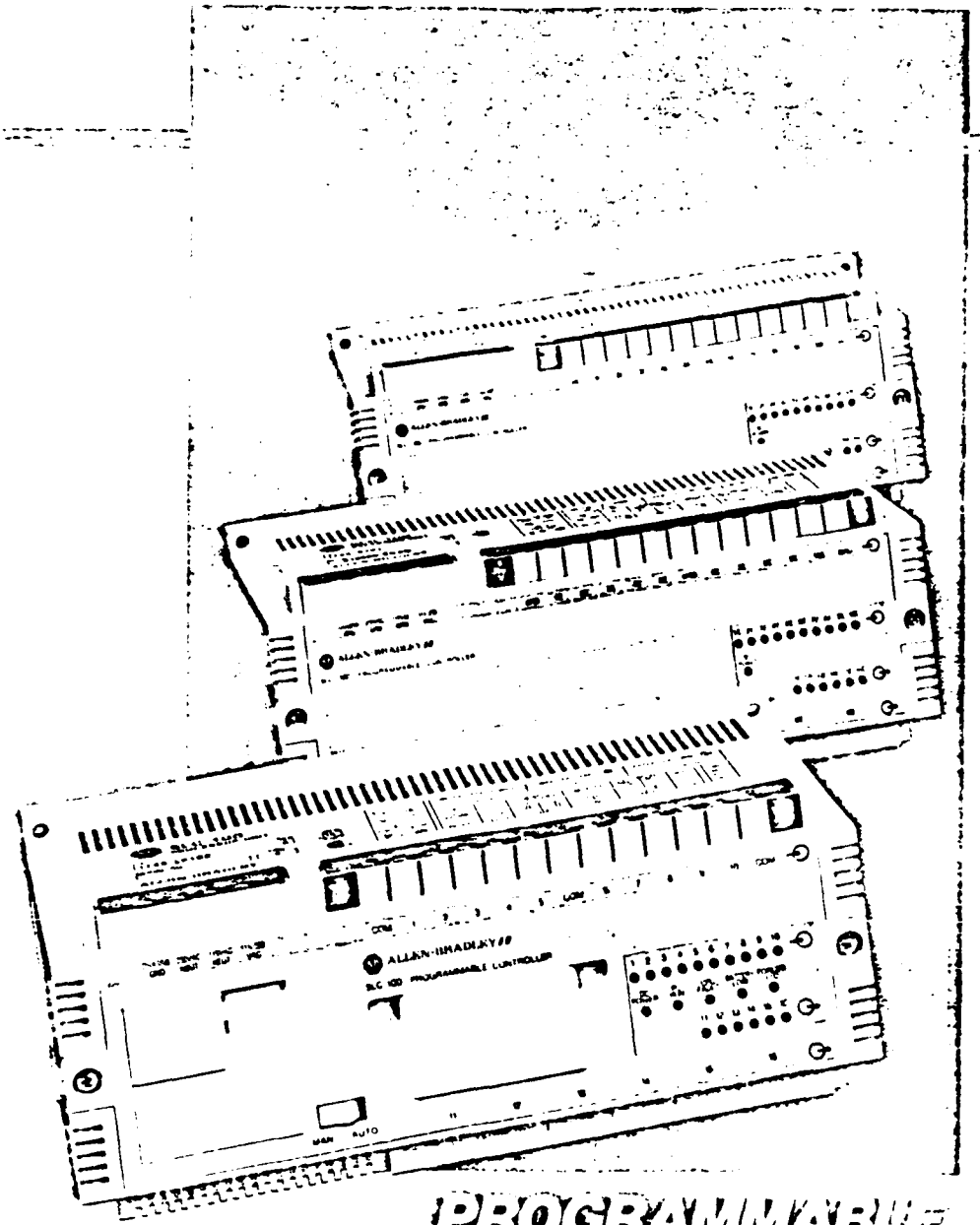
Trademarks: MAP - General Motors, Ethernet - Xerox, Token-Ring - IBM

ALLEN - BRADLEY

ALLEN-BRADLEY
A Rockwell International Company

SLC 100



PROGRAMMABLE CONTROLLER

Easy to Program

Advanced Capabilities

Tested Design

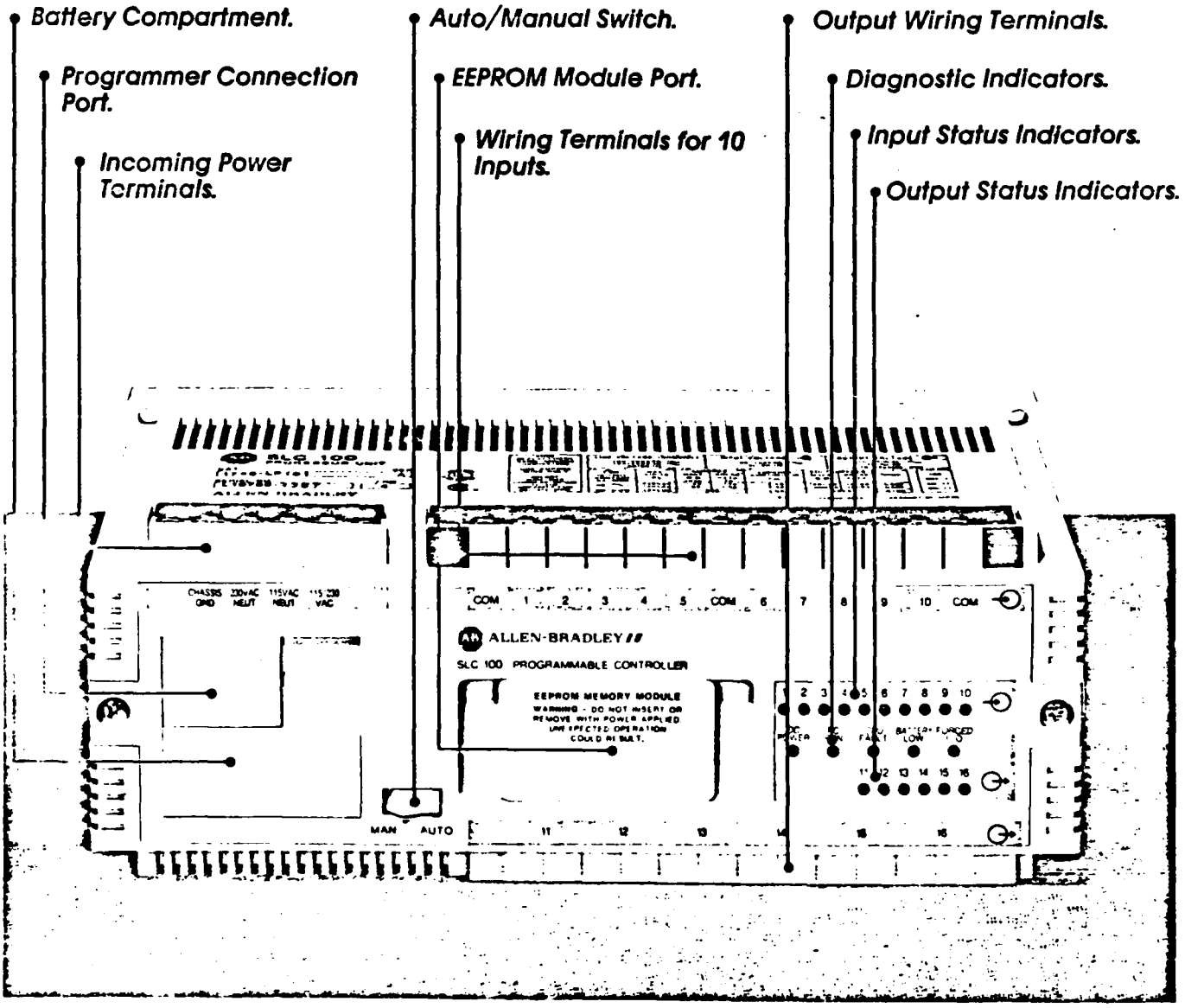
THE PROCESSOR UNIT

A Compact Controller that is Powerful and Expandable.

The heart of the controller is the processor unit, which integrates processor, CMOS RAM memory (with battery back-up), and I/O circuitry for 10 inputs and 6 outputs. An optional EEPROM memory module can be plugged into the processor unit for program loading and storage.

Expansion units can be connected to the processor unit to increase the I/O capacity of the controller to a maximum of 112. The processor and expansion units are available in several voltage versions and you can mix different versions to meet your application requirements.

Processor and expansion units can be DIN rail mounted for quick, easy installation. There are also 4 holes in the base of the units to accommodate panel mounting.



THE POCKET PROGRAMMER

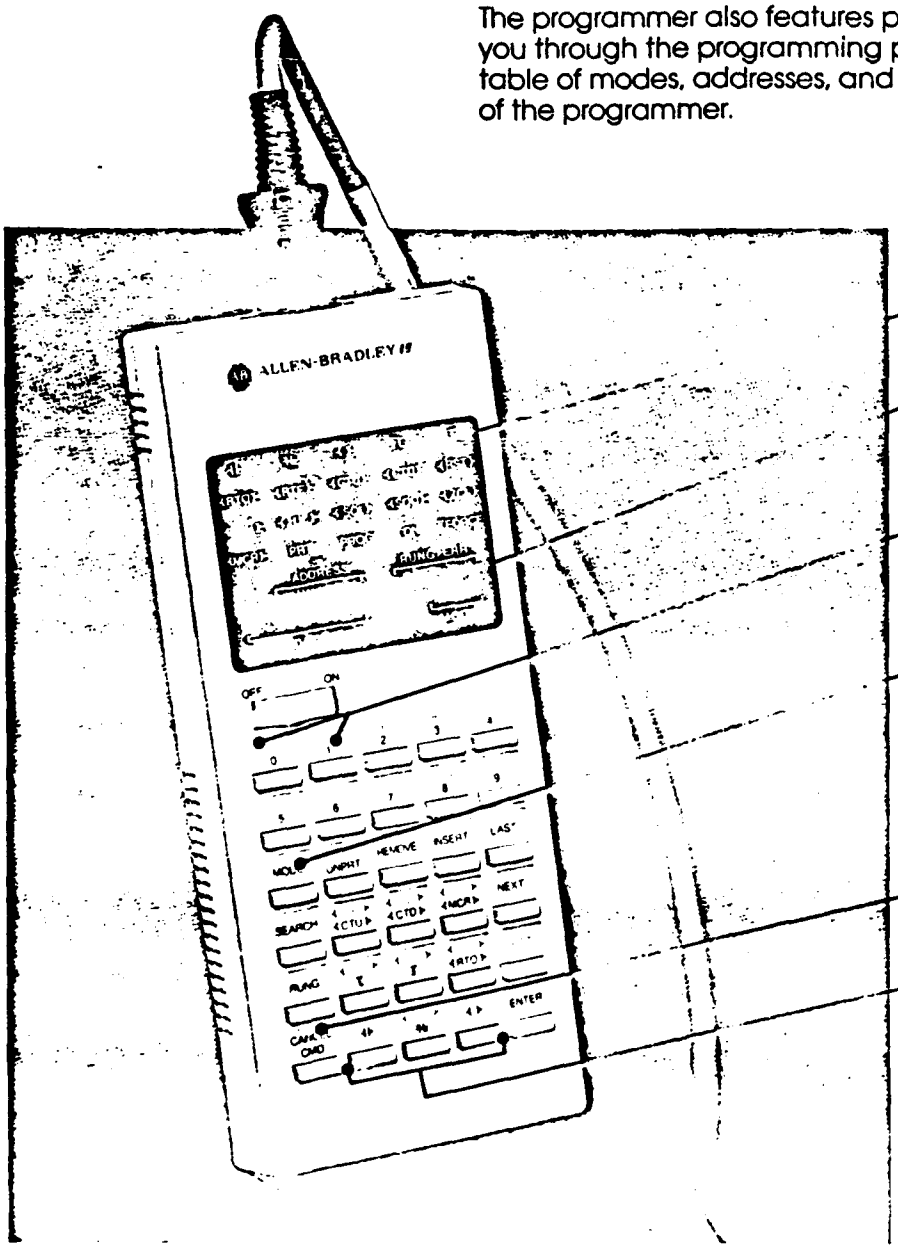
A Pocket Sized Programmer with the Features You Need for Fast, Accurate Programming and Monitoring

The Pocket Programmer is used with the SLC 100 Programmable Controller to program, monitor, edit, and troubleshoot. An interconnect cable, attached to the programmer, can easily be connected to the processor unit.

A comprehensive User's Manual and Self-Teach Manual are included with the programmer. The User's Manual guides you through installation, programming, operation, and maintenance of the controller. The Self-Teach Manual is a self-paced teaching guide featuring questions, answers, and examples to assist the first time user.

The SLC 100 Pocket Programmer features raised keys, a large LED display, an ON/OFF switch and password protection to guard against unauthorized use.

The programmer also features prompting messages to help guide you through the programming process. For your convenience, a table of modes, addresses, and error codes appears on the back of the programmer.



Pocket Programmer Display

- **Square LEDs** indicate the instruction being entered, edited or monitored
- **Seven-segment LED display** shows instruction address, rung, mode, error code and other information.
- **Force Off** and **Force On** function keys enable you to energize and de-energize inputs and outputs for rapid program check-out.
- **Mode** function key allows selection of nine operating modes including the following
  - CLEAR MEMORY
  - PROGRAM
  - RUN
  - TEST-SINGLE SCAN
  - TEST-CONTINUOUS SCAN
  - SAVE TO EEPROM
  - READ FROM EEPROM
  - PASSWORD
  - DIAGNOSTIC TEST-PROGRAMMER
- **Cancel Command** key will clear an instruction.
- **Instruction** keys are conveniently located in the center of the keyboard. These represent the following
  - RELAY – TYPE INSTRUCTIONS
  - TIMERS
  - COUNTERS
  - SEQUENCERS
  - SHIFT REGISTERS
  - MASTER CONTROL RESET
  - ZONE CONTROL LAST STATE

SPECIFICATIONS

PROCESSOR UNIT	**Incoming Voltage**	85-132 VAC, 50/60 Hz; 170-265 VAC, 50/60 Hz; 18-30 VDC
	Memory Type	CMOS RAM with battery back-up. Optional plug-in EEPROM Memory Module
	Memory Size	885 words
	Battery Backup	Replaceable with 2-year typical life
	Scan Time	25 microseconds per contact instruction, 15 milliseconds per typical program (based on 500 word program)
	Internal Relays	181 maximum
	Timers, Counters, Sequencers, Shift Registers	32 total (any combination, retentive)
	Timer Range	0.1 seconds to 999.9 seconds in 100 millisecond increments. In addition, fine-time base instructions down to 10 milliseconds are provided.
	Counter Range	1 to 9999
	Sequencers	8 bit groups, 100 steps, time or event driven
	Shift Registers	8 bit groups, cascadable, time or event driven
	Programmer Access Code	User defined password for program security
	Input/Output	10 input, 6 output
	Dimensions	3.75" (95mm)H x 9.81" (250mm)W x 4.88" (124mm)D
	Weight	4.1 lbs. (1.9 kg)
	Environmental Ratings	0-60°C, 5-95% humidity without condensation
	Installation	Mount via choice of screw fasteners or DIN rail mount. Mount on custom panel or motor control center.
EXPANSION UNITS (INCLUDES EXPANSION CABLE)	**Incoming Voltage**	85-132 VAC, 50/60 Hz; 170-265 VAC, 50/60 Hz; 18-30 VDC
	Connection	15.5" quick disconnect ribbon cable
	Input/Output	10 input, 6 output and 0 input, 12 output
	Dimensions	3.75" (95mm)H x 9.81" (250mm)W x 4.88" (124mm)D
	Weight	3.9 lbs. (1.8 kg)
	Environmental Ratings	0-60°C, 5-95% humidity without condensation
SLC POCKET PROGRAMMER (INCLUDES INTERCONNECT CABLE)	**Supply Voltage**	Supplied from Processor Unit
	Connection	Quick-disconnect, 6-foot (2m) cable (supplied with programmer)
	Communication	RS422
	Contact Matrix	Virtually unlimited
	Modes of Operation	Clear Memory, Program, Run, Test-Single Scan, Test-Continuous Scan, Save RAM to EEPROM, Read EEPROM to RAM, Enter/Change Access Code, Diagnostic Test
	Dimensions	7.52" (184mm)H x 3.00" (76mm)W x 1.08" (27mm)D
	Weight	0.57 lbs. (0.26 kg)
	Environmental Ratings	0-50°C, 5-95% humidity without condensation
INPUT CIRCUIT (PROCESSOR AND EXPANSION UNIT)	**Circuits Per Unit**	10 or none
	Voltage	85-132 VAC, 170-265 VAC, 10-30V AC/DC
	Solid State Compatibility	Can withstand 2 mA leakage current per AC input circuit
	Isolation	All inputs optically isolated. All inputs current sinking.
	Terminal Covers	Protective terminal covers with write-on area
	Indicators	LED indicators for each circuit
OUTPUT CIRCUIT (PROCESSOR AND EXPANSION UNIT)	**Circuits Per Unit**	6 or 12
	Starter Size Compatibility	NEMA Size 0 through Size 5
	UL Listed Contact Ratings	(see table below)
	Isolation	All circuits isolated
	Output Form	Hard contact relay (Normally Open)
	Contact Material	Gold overlay, silver-nickel alloy
	Terminal Protection	Protective terminal covers with write-on area
	Indicators	LED indicators for each circuit

Max. Volts	Amperes	
	Make	Break
240 VAC	7.5A	7.5A
120 VAC	15A	1.5A
125 VDC	22A	

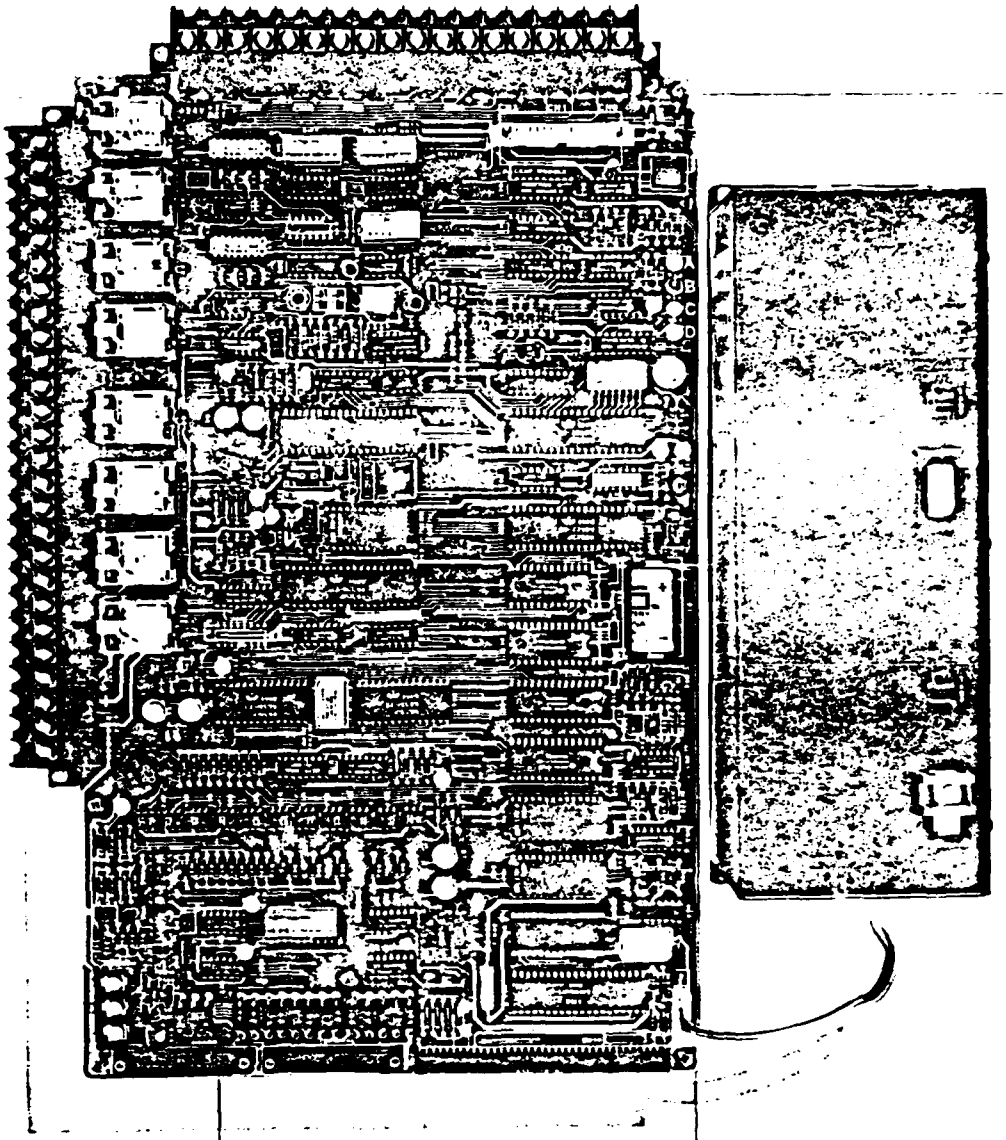
ALLEN-BRADLEY
A Rockwell International Company

Industrial Control Division
Milwaukee, Wisconsin 53204

Publication 1745-1.0 — February, 1986
Supersedes Publication 1745-1.0 Dated June, 1985

AMERICAN AUTO-MATRIX

MCU



THE MICRO CONTROL UNIT (MCU)

The MCU is a 16-point, stand-alone control panel. The MCU features English language, menu-driven operator interface, local programming, data trending and dial-in/out communications.

In stand-alone applications, the MCU is a component of the AI2100/REX® System. MCUs may also communicate with a SAC in AI2100/MAX® and other AI2100 host systems using various communications networks.

The MCU is a single module containing the microprocessor, memory, communications interfaces, clock/calendar, support circuitry, power controller, terminations and input/output circuitry.

A multi-tasking firmware executive program makes the decisions necessary for local monitoring and control. The program manages all of the microprocessor's resources including memory and communications.

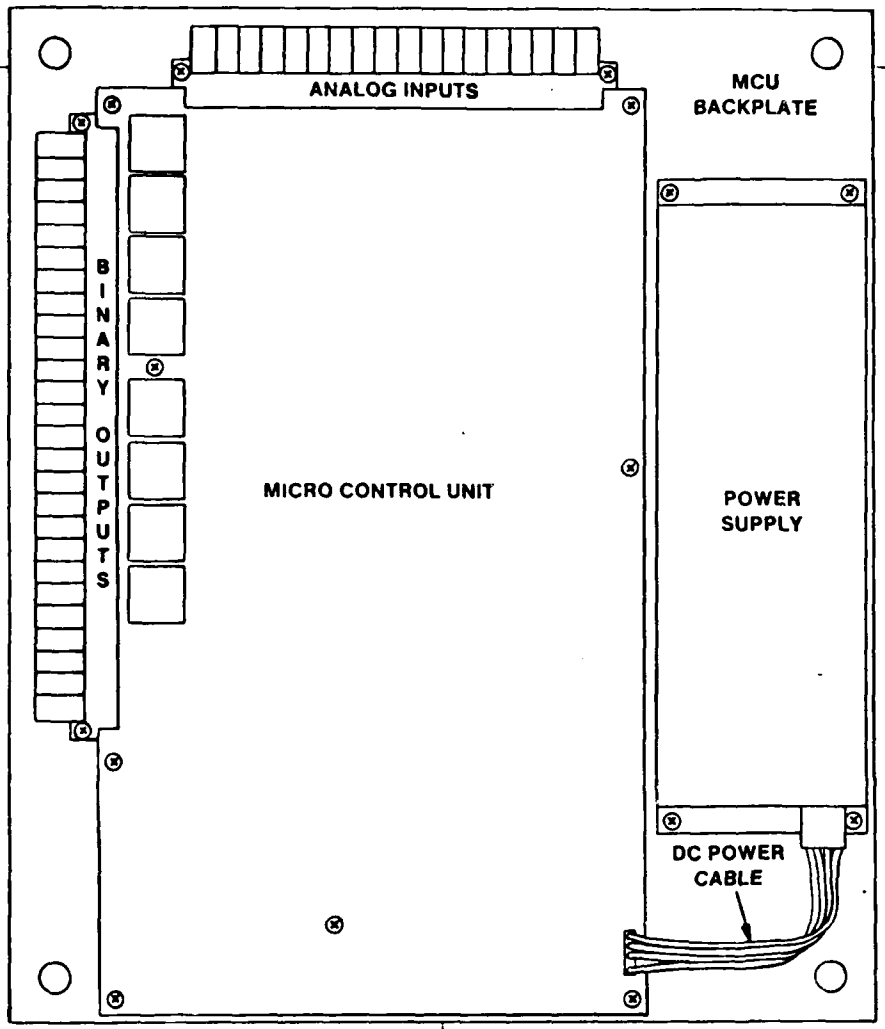
The terminations serve as the system's interface to plant equipment. All wires from sensors and controlled equipment are connected to screw terminals.

The input/output circuitry features eight analog inputs and eight binary outputs. The use of firmware configures the MCU for specific applications. Firmware packages are available for applications such as motorized direct digital control, fire and security management, and multiplexed position-proportioning control of motorized positioners or E/P switches.

MCU FEATURES

- Microprocessor-based, stand-alone and networked operation
- User friendly, English language, menu-driven operation
- Nonvolatile memory; saves entire database and all attributes for up to 1.5 years at 25° C without power (10-year battery life)
- Battery backed-up clock/calendar
- Multi-tasking, real-time executive program
- Modular firmware to tailor panel to application

MCU (OVERALL DIMENSIONS 17.0 in x 14.5 in / 43.2 cm x 36.8 cm)



- Seven local DDC loops
- Eight analog inputs and eight binary outputs
- Built-in thermistor support for analog inputs
- Flexible network communications options:
  a. up to 9600 baud over two-wire, balanced line network similar to RS422A (RS485) up to 5000 feet
  b. leased-line network (1200 baud using 202T modems or 9600 baud using "short haul" modems)
  c. dial-up using Hayes Smartmodems* (300, 1200, 2400 baud)
  d. (optional) redundant communications interface for critical applications
  e. supports Public Host Protocol (PHP)
- Transient and noise protection including full optical and magnetic isolation of communications lines
- Watchdog timer and auto-restart after power failure
- 115/230 VAC operation
- Easily accessible field terminations
- ROM-based system firmware
- 2K bytes system RAM, 18K battery backed-up RAM, 64K bytes ROM, expandable to 96K
- Diagnostic indicators for communication and processor status
- True multi-tasking execution of multiple concurrent programs
- User-programmable trending of up to 160 variables; up to 32 samples of each variable can be stored using a trend
- Complies with FCC rules Part 15, Subpart J, Class B Computing Device
- Optional memory back-up cartridge for uploading and downloading of database and programs
- Applications include: direct digital control, optimum start/stop, load shedding, enthalpy control, utility reporting, valve and damper modulation, heavy equipment start sequencing, maintenance management, run-time totalization and fire and security management
- Built-in power isolation relays (10 A, 240 V, Form "C")
- Can store up to 40 custom-designed programs

MCU SPECIFICATIONS**

Power Supply Unit Input Power:
115/230 VAC, 50 W
Operating Temperature:
32°-158° F, 0°-70° C
RAM Battery Back-up:
1.5 years (10-year battery life)
I/O Capability:
Eight analog inputs, eight binary outputs
Communication Speed:
300-9600 baud for each interface (software selectable)
Communication Interface(s):
One RS232C, one RS232C/RS485 selectable (additional RS232C/RS485 interface option available)
Shipping Weight:
(MCU, Backplate, Power Supply)
10.0 lbs., 22.0 kg.

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One Technology Drive
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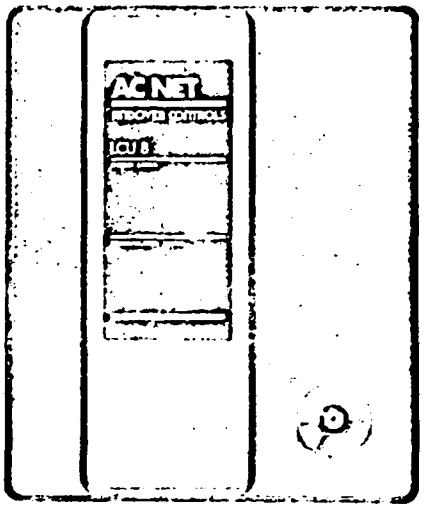
**Specifications subject to change without notice.

486MCU

ANDOVER CONTROLS CORPORATION

ACNET LCU8
Local Controller Unit



The LCU8 is an intelligent stand alone controller that is used for cost effective Direct Digital Control of equipment such as VAV boxes, fan coil units, smaller air handling units, perimeter radiation, lighting, etc. The ACNET communication protocol provides the LCU8 the ability to communicate with an AC256 Master Plus or AC8 Plus as well as all other LCU8s on the network. Up to 64 LCU8s can be networked on one AC256 Master Plus Controller, and up to 3 LCU8s can be networked to one AC8 Plus.

Communications to the LCU8s are handled through the ACNET bus. The bus is essentially a twisted pair, half duplex RS-485 interface. LCU8 communications are actuated through the asynchronous serial communications port on the AC256 Master Plus or AC8 Plus. Data transmission rates are switch selectable for 300, 1200, and 9600 baud.

Driven by a microprocessor accessing 8K bytes of RAM and 16K bytes of EPROM, the LCU8 provides a user with eight locally controlled inputs and outputs.

Each input channel is capable of being wired to accept digital, pulse (2 HZ), or voltage input. In addition, the inputs provide appropriate circuitry to interface a specified thermistor temperature sensor.

Each Universal output of the LCU8 can be configured as a Form C relay, variable Voltage, or a variable current output. To facilitiate field maintenance, all input and output points are accessible through detachable connectors.

LOCAL OPERATION

Each LCU8 is a stand-alone, microprocessor-based, intelligent local control unit that provides 8 inputs and 8 outputs for monitoring and control of building equipment. The ACNET provides a transparent bus structure for communication with other LCU8s, AC256M Plus, or AC8 Plus controllers. During each ACNET scan the AC256M Plus or AC8 Plus will broadcast its shared system variables to the LCU8 units. Likewise each of the LCU8 units will broadcast, in their turn, all of its stored data base of system variables to the AC256M Plus or AC8 Plus. In this manner the ACNET allows for the implementation of a flexible building control network, in which important control information is shared globally throughout the ACNET network.

Programs are created for individual LCU8s on the network using an AC256 Master Plus or AC8 Plus. Through a series of simple commands, the AC256 Plus opens communications to the particular LCU8 being programmed. The program is created using standard Andover Controls programming commands. Once completed, the program is stored and controlled by the LCU8.

FEATURES

- Stand alone Direct Digital controller.
- Real-Time clock.
- Global data exchange.
- User programming capability.
- Network transparency.
- Twisted pair network.
- Detachable input/output connectors.
- Universal inputs and outputs.
- Battery Backed up RAM

Andover Controls Corporation
York and Haverhill Streets
Andover, MA 01810 U.S.A.
617-470-0555 Telex 948045

SPECIFICATIONS

Memory:	16K EPROM and 8K RAM
Output Type:	8 single pole double throw (SPDT) Form C relays, 8 current outputs (0-20mA), or 8 voltage outputs (0-20 volts).
Output Rating:	5 amps at 50 VAC (Form C), 0-20mA, 0-20 volts.
Termination:	Removable two-piece terminal strip type (seven termination points per output) labelled C, NO, NC, I, V, +24, return.
Operation:	Each Universal output can be wired for Form C, 0-20mA, or 0-20 volt operation.
Output Resolution:	0.1 sec. for Form C, 0.1mA for variable current output, and 0.1 volt for variable voltage output.
Input Voltage Range:	0-8.19 volts DC.
Input Protection:	All inputs can withstand continuous shorting to 120 VAC or to plus/minus 1500 volts for 50 microseconds.
Power:	24 VAC power supply. 115 VAC power supply available as an option. 230 VAC/50 HZ power supply available as an option.
Dimensions:	17 inches × 14.5 inches × 4 inches.

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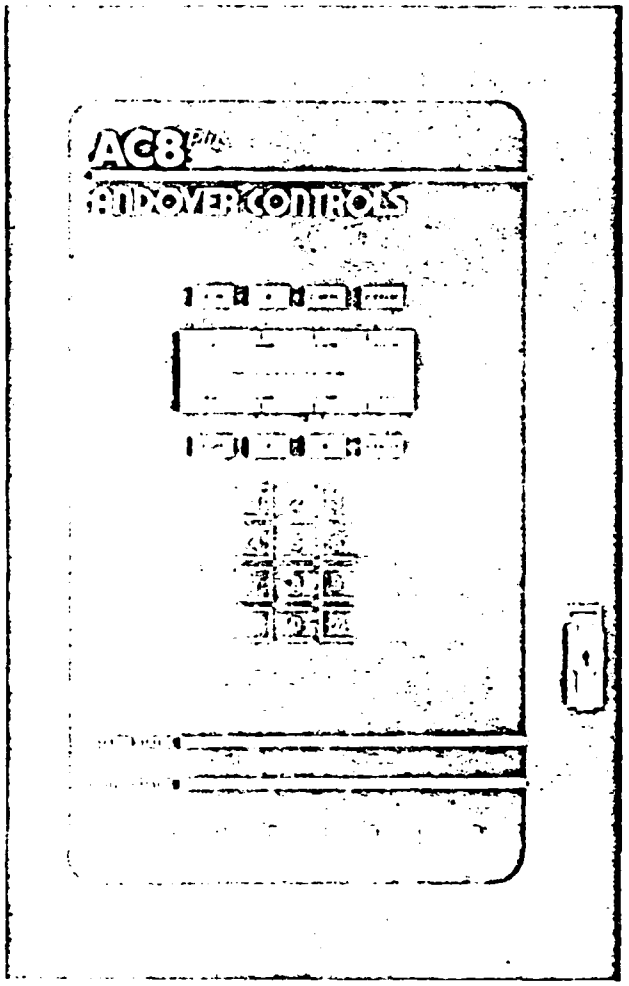

AC8 PLUS
SMALL BUILDING CONTROLLER

The AC8 Plus is a stand-alone controller that provides Direct Digital Control capabilities for the smaller building. The AC8 Plus can be networked with other AC8 Plus, AC256 Plus and LCU8 units for applications requiring additional I/O capability.

A single AC8 Plus controller can sense up to 16 inputs and control 8 outputs. Each AC8 Plus provides unique flexibility in structuring input/output points. Any input can be software defined as an analog (voltage or current), temperature, digital (on or off), or pulse counter (up to 2 Hz.). Each universal output can be configured to function as a single-pole double-throw (SPDT) Form C relay, variable current (0-20mA), or variable voltage (0-20 VDC) output. These outputs will provide both on/off switching or modulating control of equipment.

FEATURES

* Optional 20 Key 'Soft-Touch' Keypad & LCD Display
* Universal Inputs and Outputs
* Detachable Connectors
* ACNET Compatible
* Software Selectable Baud Rates
* Optional Andover Controls 300/1200 Auto-Baud Modem
* Optional Modem-Mate Speech Module
* Global Communication To Other Controllers
* Full Functional Battery Back-up

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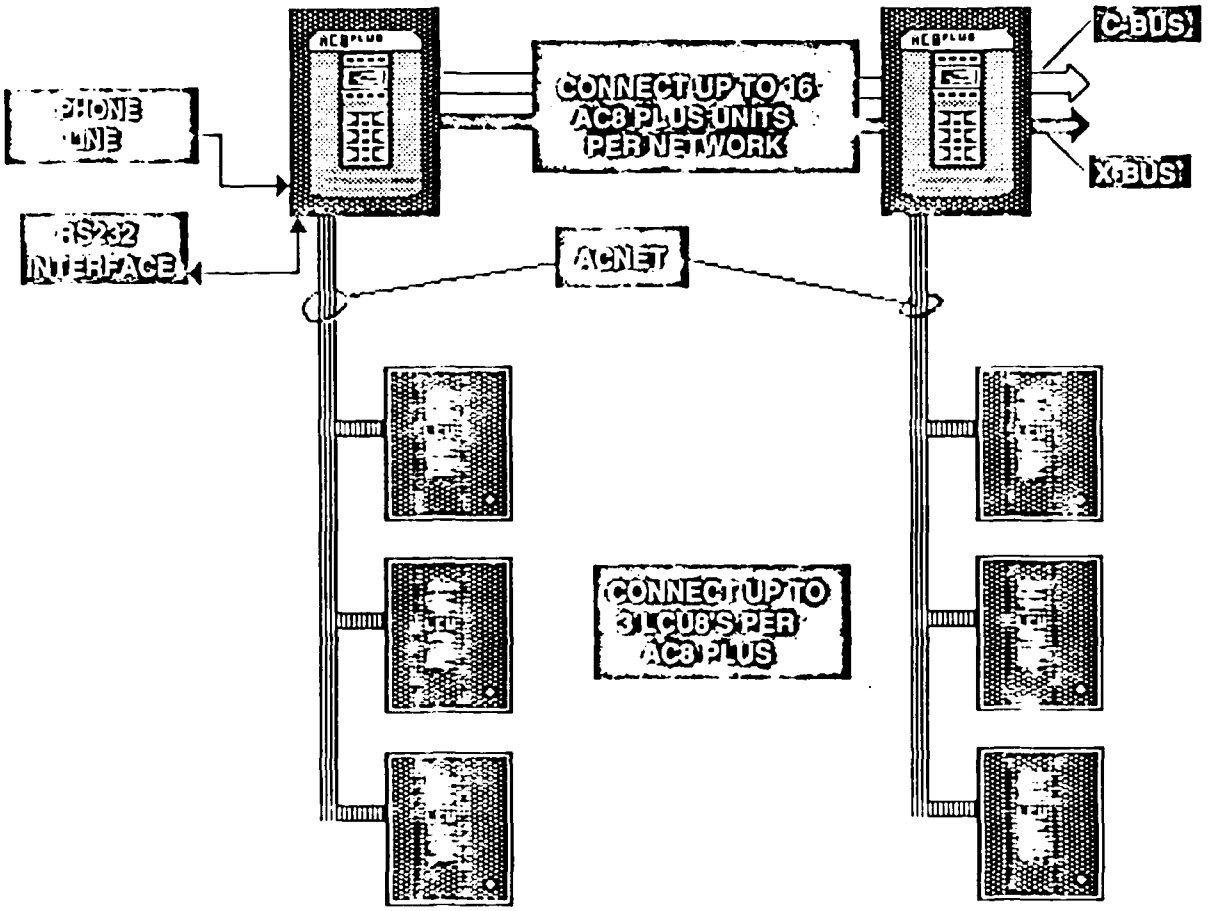


For greater distribution of processing power and input/output capacity, simply add LCU8 controllers to the AC8 Plus over the ACNET bus. Each LCU8 is an intelligent, local controller capable of sensing up to 8 inputs and controlling 8 outputs. A total of 3 LCU8 controllers can be connected to the AC8 Plus. A single AC8 Plus can control as many as 40 inputs and 32 outputs.

The AC8 Plus networked to LCU8 controllers provides you with modular, distributed intelligence and a flexible input/output structure, thereby increasing the point capacity and processing power of your system as your needs grow.

OPERATOR DISPLAY PANEL (Optional)

The optional Operator Display Panel of the AC8 Plus is equipped with a 20 key 'soft-touch' keyboard and an 8 line by 40 character display. The display echoes all data entered from the keyboard and can be programmed to display messages or menus.

The keyboard consists of both numeric and function keys. The numeric keys can be used to enter control setpoints, access codes, or any data appropriate for a particular application program.

The function keys control the operations of the front panel, manipulate displayed data, or invoke user-defined software functions.

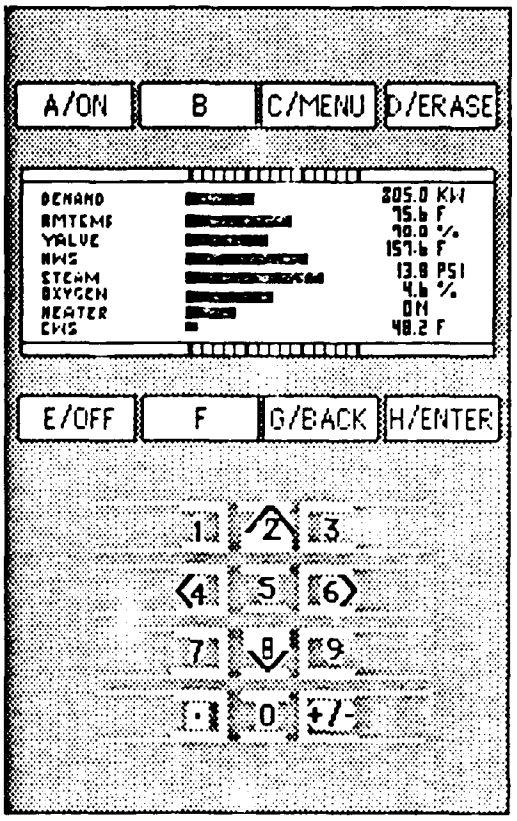
BATTERY BACKUP

There are two modes of battery backup available. Mode 1 maintains all Central Intelligence Unit (CIU) activity for up to 3.5 hours. Mode 2 maintains all CIU and Input/Output (IOU) activity for up to 1 hour. Longer times are available with external batteries.

300/1200 AUTO-BAUD MODEM (Optional)

The Auto-Dial/Auto-Answer 300/1200 Baud Modem option allows the AC8 Plus to receive or initiate exchanges of information over standard (voice-grade) telephone lines. The auto-dial feature can be easily programmed to notify central computers, remote terminals, and paging devices of any detectable condition. Using pulse or tone dialing modes, this option is capable of auto-answer, auto-dial, and auto-repeat dial.

The 300/1200 Baud Modem can relieve maintenance personnel from routine on-site monitoring duties. It allows owners and operators to monitor building control systems from a remote location and track control system performance, change time schedules, change temperatures, or even change operating programs. The modem also sets up a channel of communication for AC8 Plus to initiate control actions and share information.



MODEM-MATE SPEECH MODULE (Optional)

The Modem-Mate voice communication option offers a convenient telecommunications feature that makes it easy to communicate with a remote Andover controller.

Used in conjunction with the 300/1200 Auto-Dial/Auto-Answer Modem, the Modem-Mate allows you to receive a verbal phone message from your controller. Using the keypad of a touch-tone phone you can enter data, change setpoints or schedules, and request system status. In addition you can have a Modem-Mate verbally prompt the user for this information.

The Modem-Mate provides a fixed vocabulary of about 500 words that can be spoken individually or connected in phrases or sentences.

SPECIFICATIONS

General

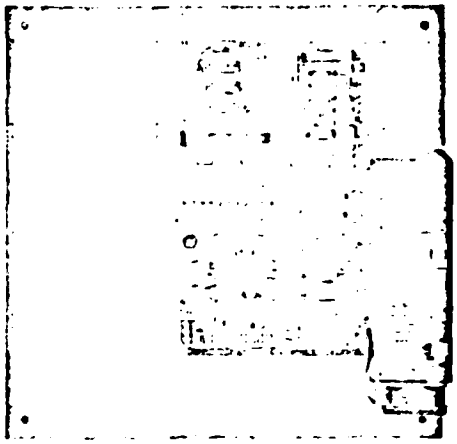
Power:	117 VAC +/- 20%, 60 Hz 220 VAC +/- 20%, 50 Hz
Power Consumption:	35 Watts or .5 Amps
Operating Environment:	40 to 120 deg. F, 10 to 95% RH
Memory Size:	32K RAM, 64K EPROM
Battery Backup:	3.5 hours (Mode 1) or 1 hour (Mode 2), expandable
Overload Protection:	.75 Amp slow blow fuse
Real Time Clock:	Synced to 60 Hz line with crystal back-up
Communication Interface:	RS232C
Communication Speed:	300 to 19.2K Baud selectable
Bus Length:	4,000 ft. standard, EZ-Link amplification module allows extension to longer distances.
Size:	24H x 16W x 6D
Weight:	49 lbs.

Inputs/Outputs

Number of Inputs:	16 to 640 (expandable in groups of 8 or 16)
Number of Outputs:	8 to 512 (expandable in groups of 8)
Input Voltage Range:	0-8.19 Volts, (inputs can be digital, analog, thermistor or counter)
Input Protection:	All inputs can withstand continuous shorting to 120VAC or to 1500 Volts for 50 microseconds
Outputs:	Eight Single Pole Double Throw (SPDT) Form C, eight current outputs 0-20 mA, eight voltage outputs 0-20 mA.
Termination:	Removable terminal strip (seven termination points per output) labeled C, NC, NO, I, V, +24V, Return
Operation:	Each Universal output can be wired for Form C, 0-20 mA, or 0-20 Volt operation
Output Resolution:	0.1 second (Form C), 0.1 mA, or 0.1 VDC
Overrides:	Every AC8 Plus output has a Hands-Off-Automatic (HOA) switch with status feedback to the operator. Each output is equipped with a potentiometer to adjust/set current or voltage levels in override condition.

BARBER-COLEMAN COMPANY

SPECIFICATION DATA



RCU2

REMOTE CONTROL UNIT 2

BENEFITS

The NETWORK 2100 RCU2 is the primary device used in NETWORK 2100 installations for direct digital control (DDC), alarm monitoring, time-based scheduling and data trending of all operational elements.

This unit supports local operator access and is capable of operating as a stand-alone unit or in a network with a central controller. The ability to support custom high-level language programs makes the RCU2 ideal for tailoring systems to specific applications. This stand-alone programming feature also allows the RCU2 to continue to operate in the event communication with the central controller (SAC) is lost.

The RCU2 is available in hardwire, leased line or dial-up version.

SYSTEM ARCHITECTURE

FOUNDATION MODULE

- RCU2 central processing unit
- Interface to communicate with the network central controller (SAC)
- Clock/calendar
- Memory (66K of operating system RAM and ROM, 18K of battery backed user RAM)
- Multi-tasking firmware for local monitoring and control

TERMINATION MODULES

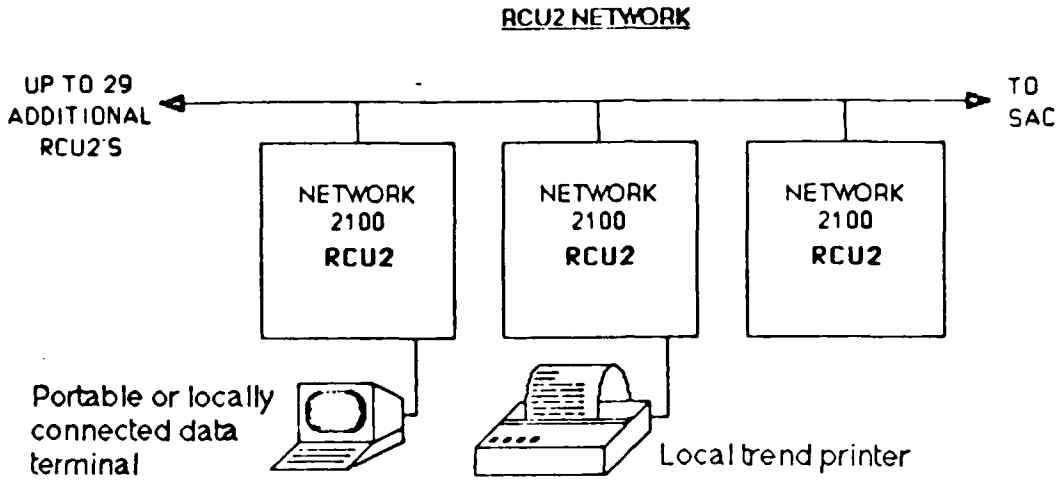
- Hardware interface between the RCU2 and all operational elements
- Includes screw terminals for wire connections to all sensors and controlled equipment
- TM-3 version available for passive thermistor input

INPUT/OUTPUT MODULES

- Each RCU2 can support 1, 2 or 3 I/O modules
- Determine what types of input and output points can be connected to the RCU2
- Determine the types of DDC loops that will be available to control the corresponding points
- Are available in 7 different hardware configurations
  1. Module A1 - 16 analog inputs
  2. Module A2 - 8 analog inputs, 8 binary outputs
  3. Module A3 - 8 analog inputs, 4 analog outputs
  4. Module A4 - 8 analog inputs, 8 pneu outputs
  5. Module B1 - 8 binary inputs, 8 binary outputs
  6. Module B2 — 16 binary inputs
  7. Module B3 — 16 binary outputs
- Are available with a variety of firmware packages that enable modules of the same hardware configuration to function in different control applications

FEATURES

- Microprocessor based stand alone operation
- Multi-tasking, real-time processing capable of 16 bit arithmetic including hardware processing of add, subtract, multiply and divide circuitry
- Up to 32 RCU2s can be networked together with one SAC
- Up to 32 RCU2s can share one 2,2T modem in dedicated leased line applications
- Built in non-volatile algorithms for proportional, integral and derivative (PID) control (see I/O module specifications for additional information on control algorithms refer to I/O module specifications)
- Built in clock has 1 second resolution and allows day of the week and yearly holiday scheduling
- Battery backup saves programmed software and clock/calendar functions for up to 1.5 years @ 25°C in the absence of power
- RCM memory expandable to 96K



FEATURES Continued

- Optional memory backup cartridge available for uploading, downloading and transporting the database and programs
- Built-in high and low limit alarming with enable/disable capability
- All operational points, including alarm monitoring, are updated every 1.5 seconds maximum
- Alarm information includes point name, time, date and type of alarm
- Alarm information can be sent directly to a terminal attached to the RCU2 or the SAC
- The dial-up version of the RCU2 will alternately dial-up a primary or secondary remote terminal until communications are achieved to report alarm information
- Data trending allows creation of trend logs
- Each data trend log can record 128 data samples for 4 separate points with sample intervals ranging from 1 to 32,767 minutes
- Modular I/O, can be individually selected to tailor panel to application
- I/O modules use pin-socket connectors for easy changeout and vibration resistant cable free connection
- Up to 24 local direct digital control loops available
- Up to 48 points of mixed analog and digital input/output
- Operator communications port for local CRT or printer (RS-232C) 300-9600 baud software selectable
- Password protected and has 2 operator access levels for system security
- Operator interface is totally menu-driven in full English language and only displays menu choices available for specific operator access levels
- Supports up to 40 user-written software programs or data trends for customizing specific applications
- Custom programs are written in high level language similar to BASIC that supports arithmetic, Boolean and if-then logic
- Network communications up to 9600 baud on multi-drop, balanced line
- Communication ports have magnetic and optical isolation to provide transient and noise protection
- Diagnostic display indicators for communication and processor status
- Watchdog timer and auto-restart after power failure
- 24 Volt operation for simple battery backup
- Easily accessible field terminations
- ROM-based system software
- Dial-up version available for RS-232C communication with the addition of a smart modem
- Gateway version available for dedicated/leased-line applications
- Complies with FCC rules Part 15, Subpart J, Class B Computing Device

SPECIFICATIONS

- Power Supply Unit Input Power
  Model A 115/230 Vac, 50/60 Hz
  75 watts versions
  Model B 115/230 Vac 50/60 Hz or
  24 Vdc, 75 watts
- Power Consumption 24 W @ 24 Vdc
- Ambient Temperature
  32-158°F (0°70°C)
- Humidity 0-90% rh, noncondensing
- RAM Battery Backup 45 days
- Analog Inputs: 1.25 Vdc, 2.5 Vdc, 5.0 Vdc, 0-20 mA selectable per 8 channel groups
- Analog Outputs: 0-2.56 Vdc, 0-10 Vdc or 0-20 mA selectable per channel; power supply range 15-40 Vdc
- A4 Module Output: 0-24 psi output; supply, dry air filtered to 40 microns, 60 psi peak pressure
- I/O Capability:
  12-48 points per RCU2
- Communication
  ASCII Terminal 300-19200 baud
  RS-232C interface
  SAC 300-9600 baud
  RS-422A interface
  Modem 300/1200/2400 baud
  RS-232C (Hayes Smartmodem or equal)
- Communication Interface:
  1. RS-232C
  2. RS-232C/RS 422A selectable
- Overall Dimensions
  21.0 in × 21.0 in × 6.3 in
  (53.2 cm × 53.3 cm × 16.0 cm)
- Shipping Weight (RCU2, Backplate, Power Supply) 13 lbs (25.6 kg)

Barber-Colman Company
ENVIRONMENTAL CONTROLS DIVISION
[illegible]

BUTLER MANUFACTURING COMPANY

B8A Load Programmer

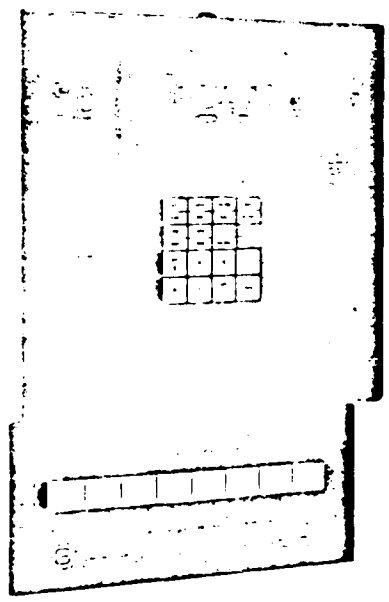
[dst]	[year]	[month]	[date]
load	day	hour	minute
[std]	[time]	[holiday]	
scan	time	holiday	
(on) 30	25	20	15
10	5	(off) 0	repeat

Benefits

- A 365-day clock provides for automatic leap-year calculation and for selection of holidays and daylight saving time dates one year in advance. This saves time in programming.
- Easy programming reduces programming and training time.
- Cycle period of 30 minutes allows only two starts per hour to save equipment wear and tear.
- Seven-day program repeats weekly to reduce programming time.
- Rechargeable battery provides 14-day protection for program and clock, so that reprogramming is not necessary after an extended power outage.
- Manual override switches may be switched to ON, OFF, or AUTO without changing the stored program.
- During programming, load relays are locked in their last position to avoid unwanted load cycling and prevent equipment wear and tear.
- CLEAR key saves time by clearing all events for a specific load on a particular day.
- SCAN quickly verifies accuracy of program.
- Five duty cycles provide run times of 5, 10, 15, 20, or 25 minutes out of every 30 minutes to reduce energy use without affecting personnel comfort or production rates.
- Three-second staging of loads prevents unwanted power surges (when more than one load is commanded on at a time).
- Photocell input to control lighting during high-ambient light conditions prevents energy waste.
- Input to stop cycling when comfort level temperatures are exceeded, thus providing savings and maintaining comfort.

Reduces Electrical Energy Consumption

The B8A Load Programmer reduces energy consumption by turning loads on and off and by duty cycling, in response to simple keypad programming.



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Each Load may be programmed with a unique schedule for each day of the week and holidays to keep energy use to a minimum.

The B8A has a 365-day clock, which provides for automatic leap-year calculation and for programming of up to 20 holiday periods a year or more in advance. Daylight saving time dates can also be entered one year in advance. A special schedule can be entered to reduce energy use on holidays.

Since holiday schedules and daylight saving time are programmed only once in the beginning of the year, programming time is saved. After the holiday has passed, the regular daily program will start again, without the B8A being reprogrammed. Also, after a holiday has passed, it is dropped from memory to permit programming of more holidays.

Simple Programming and Verification

A simple keyboard and digital display make programming and verifying easy. The keyboard is used to select the load, the day, the time for event occurrence, and the specific commands. The numeric display shows load, day, time, month, and date information.

Options

The **B8-100 Demand Limiter** continuously monitors energy use and sheds selected loads to keep kilowatt demand below a preselected set point. No load is kept off too long.

The **B8-200 Adaptive Control** automatically overrides B8A programs, in response to temperature changes, to maintain personnel comfort with minimum use of energy. The option eliminates the need for alarms and manual correction. The Advance Start feature monitors outdoor temperature and turns on selected loads earlier than the programmed start time to reach a desired comfort level. The Duty Cycle Shift function increases ON time of selected duty-cycle loads to return temperature to a user-selected range.

The **B8-400 Locking Cover** option protects against unauthorized access to the B8A front panel override switches and programming keys.

The **B8-401 Program Enable Keyswitch** provides lock-and-key program protection for the B8A. With the key switched on, the operator has full access to all B8A program functions. With the switch turned off and the key removed, the PROGRAM mode is disabled.

The **B8-500 Photocell** option provides total control of outdoor or indoor lighting. The option allows the lights to be on only when darkness is detected and the load is programmed to be ON.

The **B8-501** and **B8-502 Temperature Sensors** trigger automatic program modification when indoor and outdoor temperatures change. The B8-501 Indoor Sensor and B8-502 Outdoor Sensor are used with the Adaptive Control option. The B8-502 can be used for indoor or outdoor applications.

With the **B8-301** or **B8-302 Serial Interface** option the B8A can communicate across the campus or across the country with Pacific Technology's Load Supervisor, which features English-language data entry, display, and print-out capability for multiple B8As, or with a terminal or computer.

The **B8-600 Timed Override** option turns on loads for a programmed duration without the schedule being changed. This option may also be controlled by a thermostat, momentary switch, pressure sensor, or any device providing a contact closure.

Specifications

ELECTRICAL	
Input Voltage Requirements	115 VAC, 50/60 Hz.
Power Consumption	50 Watts nominal.
Output Relays (Load Control)	Eight normally open (N.O.) isolated relay contacts. Class 2 rated at 24 VAC, 2.3 Amps. Pilot Duty.
Circuit Protection	0.5 Amp circuit protector.
PHYSICAL	
Enclosure Data:	
Dimensions (inches and cm)	17.7" (43.2cm) H, 11" (27.9cm) W, 4½" (11.43cm) D.
Weight	Approximately 14 pounds. Shipping Weight approximately 17 pounds.
ENVIRONMENTAL	
Ambient Operating Temperature	0-50 °C. Ambient Relative Humidity 0-90%.

ZONE MASTER 100 BUILDING CONTROLLER

1.0 GENERAL

The system includes all microprocessor based software and hardware, operator input / output devices, sensors and controls, wiring, installation supervision and labor, calibration, adjustments and checkout necessary for a complete and operational system.

The following features of Butler Controls' ZM100 represent unique elements of our system which provide a superior product to systems from other suppliers.

A. The ZM 100 Building Controller is a stand-alone controller which automatically controls and monitorsup to eight (8) load groups utilizing either Power Line Carrier or hardwire communication techniques to maintain the comfort level and optimize the performance of the controlled equipment.

B. With Power Line Carrier (PLC) communication methods, the ZM 100 can be used in retrofit applications where significant savings are realized by eliminating the dedicated wiring and its related labor.

C. The system has sufficient memory and hardware capacity to support the following Input/Output (I/O) points when it is used with PLC with Intelligent Control Modules.

- Twenty Four (24) Binary Outputs
- Seventeen (17) Binary Inputs
- Nine (9) Temperature Inputs
- Sixteen (16) Alarm Inputs
- Four (4) programmable Photocell Inputs
- Three (3) Duty Cycle Override Inputs
- One (1) External Alarm Output
- One (1) Demand Limit Input; pulse or current input
- One (1) Remote Setpoint Override Input

D. The control algorithms for EMS are factory pre-programmed with all default operating parameters predefined allowing immediate use upon powering up the unit. These parameters may be modified according to individual operation requirements of the user.

E. Programming is simplified through operator prompting on a front panel mounted alpha-numeric display, and user input via a front panel mounted key pad.

F. Operating parameters entered by the user are retained by the controller for up to a week during a primary power loss.

G. The Power Line Carrier system provides Direct Temperature Control in eight (8) independent zones and zone space temperature feedback.

H. Down-loads the setpoint temperature to the remote Intelligent Control Unit via Power Line Carrier transmission technology.

I. Serial communication link allows ZM 100 Building Controller system interrogation and re-programming from a remote computer.

J. Automatically telephones predefined location to report the following alarm conditions:

- Demand Limit Input Over-range
- Demand Limit Metering Lost
- No loads to shed in Demand Limit
- Zone Temperature Alarm (9)
- Binary Input Alarm (14)

K. System status indicators to indicate if loads are in an override condition, alarms are disabled, serial communication link is active, and if demand setpoint is externally selected.

L. The system announces an alarm condition until it is acknowledged with a front panel control.

2.0 ENERGY MANAGEMENT SYSTEM HARDWARE

The system is a stand-alone controller which automatically controls and monitors up to eight (8) load groups utilizing either Power Line Carrier or hardwired communication techniques to maintain the comfort level and optimize the performance of the

controlled equipment. The system has the following features:

- 54 KB EPROM memory for pre-programmed control algorithms
- 8 KB of CMOS RAM battery backed memory for user definable operating parameters
- 40 character LCD dot matrix display mounted on the front panel
- Front panel mounted membrane key pad for program and data entry
- Eight (8) direct hardwired relay outputs
- Power Line Carrier output to 24 relays
- Remote alarm driver
- Real Time Clock
- Serial Communications
- Auto-Dial on Alarm

The system has a sufficient memory and hardware capacity for the following Input/Output (I/O) points capability.

1) Hardwired Relay Output version

- Eight (8) Binary Outputs
- Seventeen (17) Binary Inputs
- Nine (9) Temperature Inputs
- Four (4) user adjustable Photocell Inputs
- Three (3) Duty Cycle Override Inputs
- One (1) External Alarm Output
- One (1) Demand Limit Input; pulse or current input
- One (1) Remote Demand Setpoint Override

2) PLC version

- Eight (8) Binary Outputs
- Seventeen (17) Binary Inputs
- Nine (9) Temperature Inputs
- Four (4) user adjustable Photocell Inputs
- Three (3) Duty Cycle Override Inputs
- One (1) External Alarm Output
- One (1) Demand Limit Input; pulse or current input
- One (1) Remote Demand Setpoint Override Input

3.0 SYSTEM SOFTWARE

The control algorithms for EMS & TC are factory pre-programmed with operating parameters modified according to individual operational requirements.

Programming is simplified through operator prompting by a front panel mounted alpha-numeric display, and the user input is entered via a front panel mounted key pad.

All operating parameters entered by the user will be retained by the controller for up to one week during a primary power loss.

A. Energy Management System

1) Scheduled Start/Stop

The system allows the user to define schedules of equipment start/stop. The system supports up to 48 separate schedules, each containing an average of three ON, OFF or Duty Cycle events. Any number of events per schedule may be programmed, however, the total number of events can not exceed 144.

2) Optimum Start

The system allows the user to define up to 8 separate Optimum Start zones. The optimum equipment start time is calculated to minimize equipment operating hours while maintaining the comfort of the occupants. The system contains an algorithms for self-learning optimization.

3) Holiday Scheduling

The system allows the user to define up to 20 holidays in any number of contiguous days (up to 90 days). There are two different types of holiday available: HOL1 and HOL2.

4) Temperature Compensated Duty Cycling

The system allows the user to define up to 8 separate Temperature Compensated Duty Cycle zones. The system will decrease scheduled OFF time 20 percent for each degree that zone temperature is above or below the range limits.

5) Demand Limiting

The system allows the user to define up to three priority demand shed groups: Low Priority, Rotate Priority, and High Priority. Loads assigned to the Low Priority group are to be shed first and restored last. Loads assigned to Rotate Priority are to be shed only for specified periods of time. Each load in this group can be programmed with a minimum ON and a maximum OFF time. The loads in this group are to be shed only after all loads in the Low Priority group are

shed. High Priority loads are the last to be shed and the first to be restored. They are shed only after all loads in both the Low and Rotate Priority group have been shed.

Up to four individual demand setpoints may be defined, three set time-of-day scheduling, one by external contact closure.

6) Night Setback

The system allows the user to assign the Night Setback feature to all controlled loads. The user programs a minimum and maximum allowable zone temperature to zones during times they are un-occupied. To use this option, each controlled equipment must have a zone temperature sensor. Activation of heating or cooling equipment in Night Setback occurs only when the equipment is OFF by equipment schedule and the controlled space temperature is either below the minimum temperature or above the maximum temperature specified by the user for up to 8 zones.

7) Economizer Control

This program allows free cooling of the controlled space by using cooler outside air instead of mechanically cooled the return air. To use this option, an outside air temperature sensor and return air temperature sensors are required.

8) Operator Override

The system allows the operator to override operation of any controlled equipment from the central controller. The equipment can be overridden ON, OFF, or placed in the AUTO mode.

9) Timed Override

The system shall allow the user to define up to 8 Timed Override Schedules. This option will trigger the designated equipment ON upon the activation of remotely located momentary switches during the scheduled OFF period. The duration of equipment ON time shall be user programmable.

B. Direct Temperature Control

A Power Line Carrier system shall provide Direct Temperature Control in eight (8) independent zones with zone space temperature feedback.

C. Facility Management System

1) Alarm Monitoring

The following alarm conditions may be defined by user:

- Demand Limit Input Over-range
- Demand Limit Metering Lost
- No loads to shed in Demand Limit
- Zone Temperature Alarm (9)
- Binary Input Prove Signal (8)
- PLC Output Converter Faults
- Binary Contact Input Alarm (14)

Alarm messages are either printed on a local printer or dialed out to a predefined telephone number (two numbers, user programmable). The system status indicators indicate if loads are in an override condition, alarms are disabled, serial communication link is active, and demand setpoint is externally selected.

The system announces an alarm condition until the alarm is acknowledged with a front panel control. Alarms may be reset automatically or manually.

2) Status Monitoring

The system displayis the status for all loads being controlled or monitored.

3) Trending

The system monitors and maintains record for up to 31 days showing the following operational data:

- High and low temperature of each zone
- Advanced start time for each zone
- On time for each load
- Daily peak KW and time of occurrence
- Daily high, low, and average outdoor temperature
- Daily KW shed

The system also shows hourly zone temperature and peak KW for the last 24 hours.

4) Remote Communication

The system has the remote communication capability for a computer to communicate with the system via phone lines. The remote communication allows the remote user a full system access as is available from the local controller plus provides access to historical trending data.

COMPUTER CONTROLS

LOCAL CONTROL COMPUTER

The Local Control Computer (LCC-4) is at the heart of the System-IV hierarchy. All sensors and control devices are connected to the LCC-4. A combination of hardware, software and a database in each LCC-4 provides control and monitoring of the equipment.

Each LCC-4 is placed at or near air handling units, chillers, boilers, pumps, fans or any other equipment to be monitored or controlled. Several Local Control Computers are generally used in a system.

Each LCC-4 accommodates up to 32 digital inputs, digital outputs, analog inputs and up to eight analog outputs. Each LCC-4 also contains power regulators, memory, timekeepers, communication circuits, a watchdog protection circuit, internal diagnostic software routines and is fully battery backed-up to hold memory for 30 days. In its basic configuration, each LCC-4 contains 16 kilobytes of EPROM (permanent memory) and 40 kilobytes of RAM (read/write memory).

Physical Interfaces

- Digital Inputs; detect the status of two-position devices, such as switches or relays, to verify that a device has operated or indicate that a limit has been reached, and to count meter pulses, such as electrical demand or condensate meters

- Digital Outputs; control equipment; the LCC-4 contains a solid-state relay for each digital output which opens and closes to energize or de-energize the controlled devices directly, or to modulate them indirectly, through a Computer Pneumatic Interface

- Analog Inputs; read information from sensors or sensor arrays that represent continuously varying physical quantities, including: temperature, pressure, humidity, air flow, fluid flow or steam flow

- Analog Outputs; control equipment; the LCC-4 provides either voltage or current output to modulate electronic devices such as speed controllers

Features

- Compatible with pneumatic/electric valves and actuators
- No calibration required
- Interchangeable for minimum downtime
- Telephone access via modem for service/diagnosis
- Watchdog timer provides failsafe operation
- Interfaces with fire and security systems
- Battery backed-up memory
- User-friendly -- no special knowledge required to operate
- Setpoints and strategies can be changed easily -- no need to change or calibrate new hardware

At the very heart of Computer Controls Corporation's System-IV is the Local Control Computer -- LCC-4. The LCC-4 contains the intelligence needed to use the database information to monitor and control equipment. This unique microprocessor-based control device also provides the system I/O ports, a self-contained communications interface module with both RS-232C and RS-485 capabilities, internal diagnostics, watchdog timer and full battery back-up.

The LCC-4 is a completely self-contained unit specially constructed and tested for use in the typically hostile environments found in HVAC applications. All ports and connectors are color-coded for protection against wiring errors. There are no exposed circuit boards and no switch-selectable options. LED's provide immediate status and power indication, and an internal watchdog circuit continuously monitors operations.

All LCC-4's are identical and interchangeable. While each performs a unique function in a working system, that functionality is entirely defined by software, making servicing easy and reducing the need to keep spare parts. Each LCC-4 is sealed, protected from corrosive atmospheres and other environmental hazards. For extra protection, LCC-4's are usually mounted within our enclosed standard panel.

A Local Control Computer may be used as a stand-alone, in a network or operated remotely. LCC-4's are available with 52 or 104 point capacity. All models have a local read port and a telephone interface. They control small to large, simple to complex air handling units, chillers and boilers, as well as fans, pumps, lights, etc. Ports are designated as digital or analog inputs and outputs. To ensure increased reliability, each port is predefined and engineered with internal hardware customized to its designated function.

Each LCC-4 is programmed with its unique database. Changes in the software are easily made by non-technical operators using a [illegible] Manager (MS-DOS or [illegible] based Personal Computer) via telephone or dedicated communications bus, or from an inexpensive terminal connected directly to the local read port. Residing inside each LCC-4 are standard software applications packages that are enabled at the time of purchase; each LCC-4 can run all applications.

Regardless of the size of your facility, be it a single large building or a multi-site campus, the Computer Controls System-IV allows for limitless expansion by installing additional LCC-4's. LCC-4's are added to the Network simply by connecting them to the communications bus via a 6-pin connector (RS-485).

Local Control Computers are easy to install, maintain and service. These rugged units, designed and built to operate under the most difficult environmental conditions on the factory floor, are equally cost-competitive in commercial installations.

Building control functions

- Demand Limiting
- Meter/Binary Switch Read
- Enthalpy Changeover
- Local Read
- Time/Switch/Sensor based Start/Stop
- Central Alarming
- Central Monitoring and Diagnostics
- Interlock Based Start/Stop
- Time Delayed Start/Stop
- Central Reporting
- Optimized Start
- Modulation Control
- Lighting Control
- Air Handler Management - Constant Control
- VAV Control - Variable Control
- Analog and Binary Alarm Points
- Run Time Totalization
- Analog Reading Conversion
- Remote Network Communications
- Analog Reading Select/Average
- Load Executive
- Calculated Point
- Duty Cycling

Technical Specifications

Processor:	Motorola 6808
Real-Time Clock:	100 Year Calendar
Memory Size:	40K RAM 16K ROM
Communication Interface/Speed:	EIA RS-485 / 300 to 9600 Baud EIA RS-232C / 300 to 9600 Baud
Power Requirements:	+24 Vdc
Power Consumption:	6 Watts
Outputs:	16 or 32 digital outputs (semiconductor switch each rated 24 VAC @ 1 Amp) 4 or 8 analog outputs, 0 to 5V; 4 to 20 mA
Inputs:	16 or 32 analog inputs, 0 to 2V; 4 to 20 mA 16 or 32 digital inputs
Battery Back-Up:	Greater than 500 hours
Operating Conditions:	0 to 120 degrees F
Size:	12.67" W x 15.68" H x 5.00" D
Weight:	12 lbs (5.44 kg)

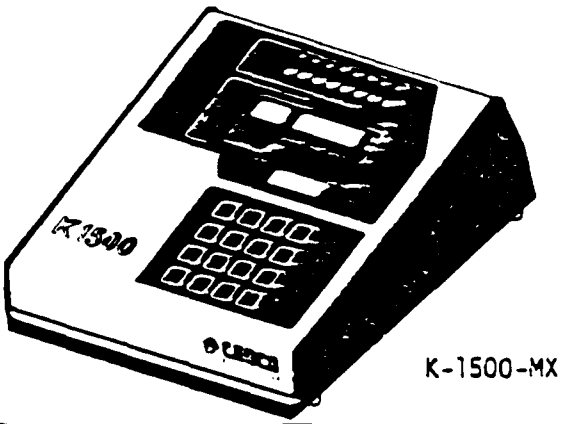
CONTROLLED ENERGY SYSTEMS COMPANY

CESCO K1500

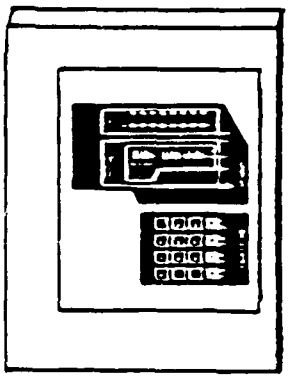
K1500 EQUIPMENT SPECIFICATIONS

The K1500 Control System is a compact, easily programmed desk/wall console used to monitor a building's environmental conditions and control the building's mechanical equipment more efficiently. The K1500 Console in conjunction with its precision real time clock, sensors and load monitors, sample the environmental conditions within a building. Based on these readings, the Console activates relays connected to the building's heating, ventilating, air conditioning and lighting systems to maintain programmed schedules and environmental conditions with a minimum of energy usage.

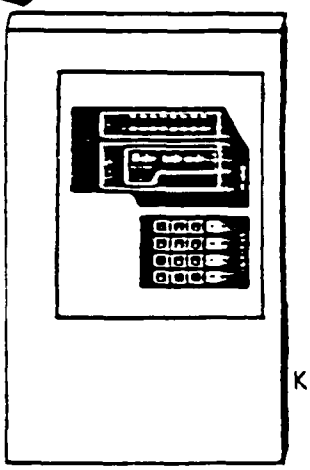
A standard RS-232C serial data interface is an option on all K1500 Control Consoles to allow the user to operate the system from a remote location via data terminal, modem and telephone lines. This telecommunications capability allows an operator of many different buildings to individually control each building in the network from a central office location without leaving his office. The communications option also offers data logging capabilities permitting hard copy documentation of load/sensor conditions for up to forty-nine hours of operation.



K-1500-MX



K-1500-8



K-1500-16

SERIES K1500
ENERGY MANAGEMENT SYSTEM
CONTROL CONSOLE
K-1500-MX
K-1500-16
K-1500-8

KEYBOARD

DATA ENTRY KEYS	16
DIGITS	0 - 9
DAYS	Sun. thru Sat., Holiday, and Mon. thru Fri. Quick Entry Key
PRCMPT RESPONSE	Yes / No / Data
INIT	Allows entry into programming/monitoring functions
CE	Clear Entry
TEST	Trouble-Shooting functions

STANDARD FUNCTIONS

PROGRAMMING	Multiple on/off times for each load. Multiple temperature interlocks for each load. Slave interlocks for programming multiple loads with the same schedules. Eight duty cycle schedules for each load. Start time optimization based on indoor and outdoor temperatures.
CAPABILITIES	Displays program parameters for load. Displays temperature for each sensor. Display program status of load (on/off) Display time-of-day, day-of-week, real-time clock. Variable comfort limit setpoints. Cassette tape interface for program back-up. Display optimization/shed status of load. Display duty cycle schedule of load. Individual programming for each load. Sensors assignable to each load.
PROMPTING	English Language Prompting. Eight Character, English Language display gives Operator guidance with functions. Informs operator of system status, error messages etc. More than 50 individual messages/questions are used.

COMMUNICATION INTERFACES

OPERATOR	Five individual visual display areas.
RECORDER	Binary Image with checksum, 300 baud standard cassette interface. Mark / space frequency 3/5KHZ
MULTIPLEX (K-1500-MX)	Two-wire twisted pair Frequency-shift Keying Mark/space frequency 8/10KHZ 16 bit word length. 5,000 feet maximum distance. Sensor/FSK cable: Belden 8450, 8451 or 8723 or equiv. 2 conductor shielded cable.

OPTIONS

COMMUNICATIONS
K-1500-8, 16, MX

RS-232-C port utilizing standard ASCI II format, serial binary data.
Software for communications with keyboard printer, CRT terminal or computer system.
Modem compatible.
300 or 1200 baud, full duplex
7 data bits, one stop bit odd parity.

Feature also offers "Data Logging". The console samples and stores temperatures, load status and demand information for up to 2 days. Information can be retrieved on demand for use in fine tuning the system.

DEMAND LIMITING

K-1500-8, 16, MX

Monitors building demand and sheds assigned sheddable loads and increases duty cycle off time of "cycled" loads.
Automatic demand limit setpoint feature compensates for seasonal changes and automatically establishes correct setpoint.
Eight Load shedding priorities
Up to eight power feeds standard with multiplex unit. Expandable to eight on 1500-8 and 16.

EXPANSION

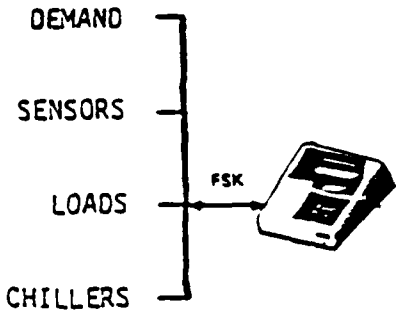
K-1500-8 & 16 ONLY

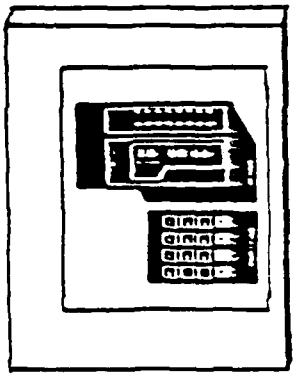
Loads expandable in groups of eight loads up to max of 72.
Sensors expandable in groups of eight sensors up to max of 32.
Load monitors expandable up to 8 in increments of one.

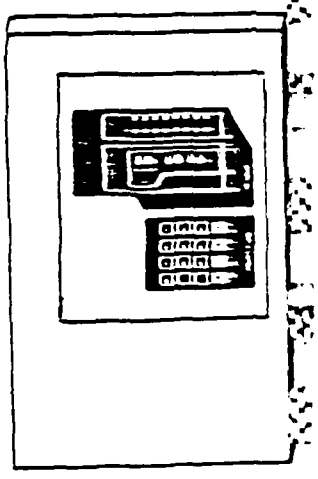
K-1500-MX
STANDARD CAPABILITY

Console capable of controlling up to 72 individual loads (Std.). . monitors up to 32 temperature sensors and 8 load monitors.(Std.).. multiplexing feature allows easy addition of relays and sensors as budget allows.

OPERATING ENVIRONMENT	+40°F To 120°F (4°C - 50°C) -20°F To 150°F Storage Temp. (-28°C - 66°C) 0 To 95% R.H. Non-Condensing		
PHYSICAL DIMENSIONS	K-1500-MX	K-1500-8	K-1500-16
Weight	7.5 lb.	30 lb.	35 lb.
Depth	11.4"	6"	6"
Width	10.2"	12"	12"
Height	4.5"	18"	24"
POWER REQUIREMENTS	30 VA	30 VA	35 VA
	95 TO 130 VAC 50 TO 60 HZ		
BATTERY BACK-UP	Rechargeable NiCd supports clock and memory for 24 days minimum.		







K-1500-MX

8 - Demand Monitors
32 - Temp Sensors
72 - Loads

K-1500-8

1 - Demand Monitor
8 - Sensors
8 - Loads

K-1500-16

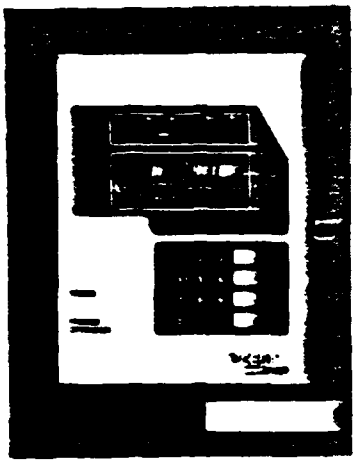
1 - Demand Monitor
8 - Sensors
16 - Loads

CONTROLLED ENERGY SYSTEMS COMPANY
P.O. Box 55548
Seattle, WA 98155

K1500 SERIES

ENERGY MANAGEMENT

MODEL 8



CESCO, with over 10 years of offering sophisticated Energy Management Controls is a continuing leader in providing systems that help you control costs without requiring a computer operator. The CESCO K 1500 Series Energy Management System manages your energy costs 24 hours a day for every day of the year. It helps your company realize the most efficient use of its energy.

The CESCO K 1500 Series Model **8** Energy Management Control System is designed for easy operator use with flexibility of upgrading and expanding your system as your facility use changes.

The CESCO K 1500 controls the equipment in your building to reduce your consumption and demand charges by as much as 10% to 30% of your total utility costs. Simply stated, that means profit for you.

FEATURES

* **8** Control Loads or Groups of Loads
* Time of Day Scheduling
  Multiple Schedules for Each Controllable Group

  Automatic Adjustment for Daylight Savings Time
* Duty Cycle Control
  Each Controllable Group Can Have Multiple Duty Cycle Schedules

  Temperature Compensated Duty Cycling
* Individual Manual Overrides for Each Control Circuit
* Battery Back Up for Memory Protection in the Event of Power Failure
* Lockable Front Door for Program Access Security
* **8** Sensor Inputs for:

Temperature	Pressure
Light Levels	Start Time Optimization
Night Setback	Temperature Compensated Duty Cycling

OPTIONAL FEATURES

* Demand Control
  Automatic Demand Setpoint

  Multiple Watt Transducer Demand Inputs
* Telecommunication for Remote Programming
* Data Gathering for Energy Usage History
* Power Line Carrier
* Chiller Control

22313-70TH AVE. W. SUITE #1 MTLK. TERRACE, WA 98043 (206) 774-1971

Time Of Day Scheduling

The K 1500 Series equipment offers one of the most flexible time schedules in the industry. With over 400 programmable schedules available, the system gives the energy manager real flexibility in programming his time requirements.

Duty Cycle Control

By cycling a load on and off during its required time frame, a significant reduction in power cost can be realized. Extreme on/off control can be harmful to equipment. CESCO has built in a short cycle prevention. With 8 duty cycle schedules available for every point with the short cycle prevention, the K 1500 Series Energy Management System is one of the most versatile control systems available. Through the use of temperature information, the "on" time of the cycled load is automatically adjusted to keep the space temperature inside the temperature "comfort zone".

Sensor Inputs

With 48 sensor inputs, the Energy Management System manager is offered almost unlimited control. These sensors may be used for temperature, pressure, air movement, light levels, humidity or power demand levels. Sophisticated control decisions based on sensor values can be utilized in facility energy use control. Up to 8 demand inputs can be coupled to the K 1500.

With the temperature input capability, optimal start-up of heating and cooling equipment can be performed by comparing outside and inside temperatures for a programmable start time that will bring the building into the "comfort zone" by the start of business.

Demand Control Option

With its self adjusting "automatic demand setpoint" there is no need to guess at a demand shed point. Just select all sheddable loads and let the K 1500 shed your demand sheddable loads in a predetermined priority. With the K 1500, there is no need to worry about the local utility demand window because the demand level is constantly monitored.

Telecommunications/Data Logging Option

The K 1500 Series Energy Management Equipment may be configured with an optional serial communications interface. Using standard voice-grade telephone lines, the option allows total remote control of the K 1500 equipment. The user may check or change any parameters in the system including on/off times, duty cycle values, setpoints, temperature values, holidays, etc. The data logging option allows the collection and retention of facility energy information including:

* Load Status for each of the 30 definable time intervals
* Sensor Readings for each of the 30 definable time intervals
* Peak KW for each of the 30 definable time intervals
* Average KW for each of the 30 definable time intervals
* Chiller conditions including chilled water supply temperature, return water temperature, number of chillers running and the percent operating level for each of the 30 definable time intervals.

SPECIFICATIONS

Electrical	Environmental	Physical
Input Power 95 to 130 VAC/30VA/50-60HZ	Ambient Operating +40°F to 120°F (4°C-50°C)	Height 18
Output Rating 24VAC/3 Amp	Temperature -20°F to 150°F (-28°C-66°C) Storage Temp	Width 14
Sensor Inputs 4-20 MA or Resistive	Ambient Humidity 0-95% Non-Condensing	Depth 6
		Weight 28#

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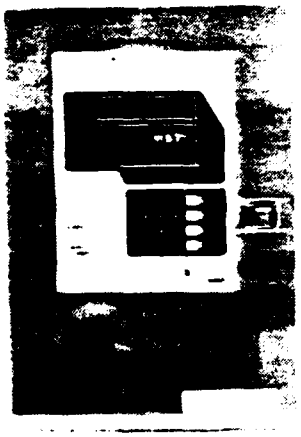
K 1500 SERIES ENERGY MANAGEMENT

MODEL 16



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The CESCO K 1500 controls the equipment in your building to reduce your consumption and demand charges by as much as 10% to 30% of your total utility costs. Simply stated, that means profit for you.

FEATURES

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* Time of Day Scheduling
  Multiple Schedules for Each Controllable Group

  Automatic Adjustment for Daylight Savings Time
* Duty Cycle Control
  Each Controllable Group Can Have Multiple Duty Cycle Schedules

  Temperature Compensated Duty Cycling
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* Sensor Readings for each of the 30 definable time intervals
* Peak KW for each of the 30 definable time intervals
* Average KW for each of the 30 definable time intervals
* Chiller conditions including chilled water supply temperature, return water temperature, number of chillers running and the percent operating level for each of the 30 definable time intervals.

SPECIFICATIONS

Electrical

Input Power
95 to 130 VAC/30VA/50-60HZ

Output Rating
24VAC/3 Amp

Sensor Inputs
4-20 MA or Resistive

Environmental

Ambient Operating
+40°F to 120°F (4°C-50°C)

Temperature
-20°F to 150°F (-28°C-66°C) Storage Temp

Ambient Humidity
0-95% Non-Condensing

Physical

Height
24

Width
16

Depth
7

Weight
36#

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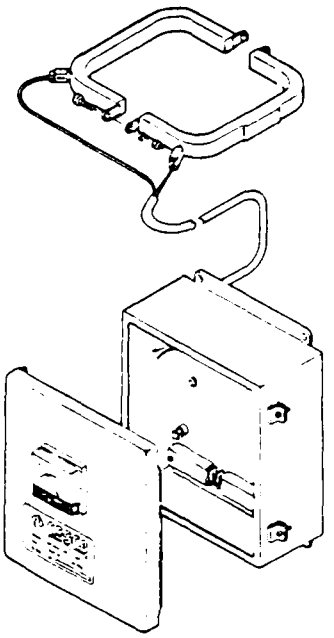
CESCO ACCESSORIES

K1500 EQUIPMENT SPECIFICATIONS

The Series K1500 Load Monitor is used to monitor a building's electrical power consumption by means of a split-core current transformer. The Load Monitor continually measures the building's current usage and converts this information into a proportional signal which is reported to the Control Console via the two wire FSK (frequency-shift keying) Cable.

Buildings with more than one electrical service require a Load Monitor for each service. Up to eight individual Load Monitors may be used in one building.



SERIES K1500 LOAD MONITOR
K-LM

ELECTRICAL

POWER REQUIREMENTS	120 VAC, 60 Hz 1VA.
COMMUNICATION BUSS	FSK two-wire twisted, shielded pair. Addressing block - up to 8 units.

SENSOR READOUT

DEMAND	Percentage of full scale rated building loa (relative), 00 - 99%; or calibrate to read directly in KW.
RESOLUTION	± 1% of full scale.

ENVIRONMENT

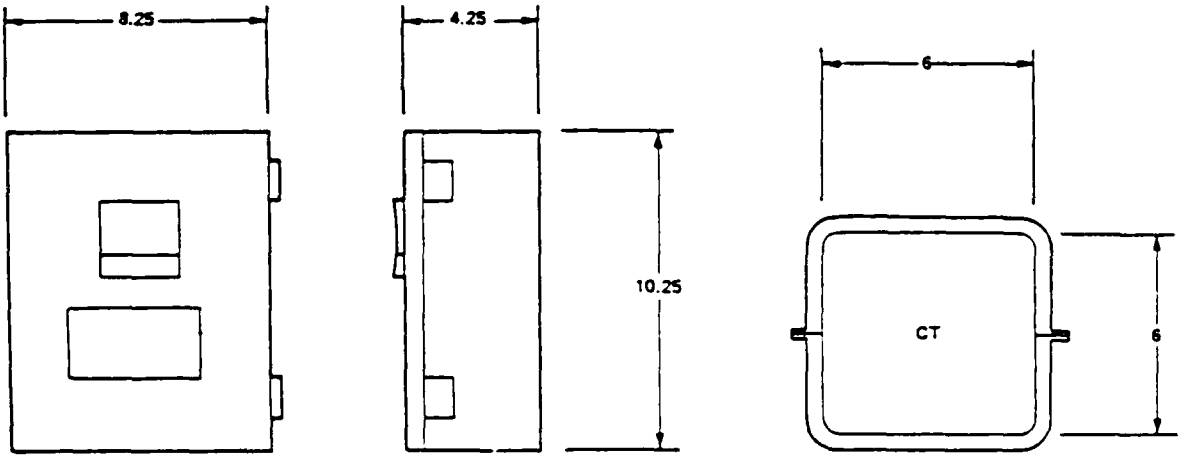
OPERATING	TEMPERATURE: 20°F to 120°F. (-6.6C to 49°C).
	HUMIDITY: 0 to 95% non-condensing.

STORAGE	TEMPERATURE: -20°F to 156°F. (-29°C to 68°C). HUMIDITY: 0 to 95% non-condensing.

PHYSICALS

WEIGHT	CURRENT TRANSFORMER: 1.75 lbs. (.794 kg). LOAD MONITOR: 9.7 lbs. (4.40 kg).
LENGTH	CURRENT TRANSFORMER: 6.0" (152.4mm). LOAD MONITOR: 10.25" (260.3mm).
WIDTH	CURRENT TRANSFORMER: 6.0" (152.4mm). LOAD MONITOR: 8.25" (209.5mm).
HEIGHT	CURRENT TRANSFORMER: 0.75" (19.05mm). LOAD MONITOR: 4.25" (107.9mm).

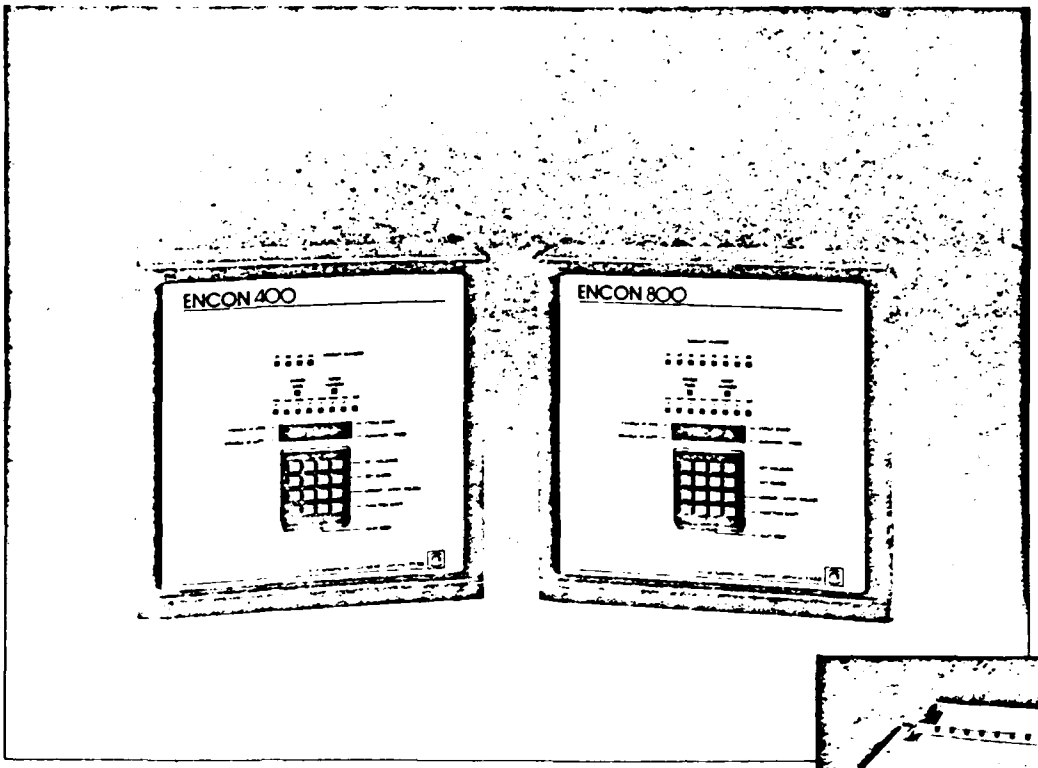
DIMENSIONS

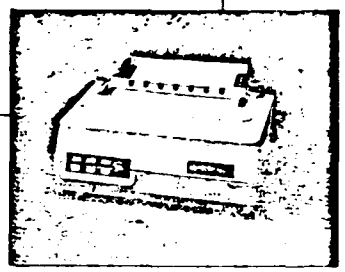


CONTROLLED ENERGY SYSTEMS COMPANY
P.O. Box 55548
Seattle, WA 98155

ENCON SYSTEMS, INC.

The Encon 400 & 800





AUTOMATIC ALARM DIAL-OUT.
A standard printer or terminal becomes your 24 hour monitoring and alarm message receiving station.

Microprocessor based electronics in the Encon 400 & 800 bring the accuracy and reliability needed for state-of-the-art energy management, environmental control, and facility monitoring. These controllers are designed for optimizing efficient and effective control of: HVAC, refrigeration, lighting, boilers, and other energy consuming equipment.

Big System Capabilities make the Encon 400 & 800 the best choice for smaller energy control applications. These units offer all of the features found in the powerful Encon 1600 & 3200 controllers.

Direct Digital Control (DDC) is an easy-to-use feature of these controllers. This capability makes Encon the logical choice for proportional control of dampers, valves, chillers, and refrigeration systems.

The Encon 400 & 800 reduce energy costs, improve comfort, and give you centralized control of your equipment and facility.

Features and Control Strategies Include:

- ☐ Analog Control and Variable Cycling
  - Reads and responds to temperature, pressure, humidity and other sensors
- ☐ Direct Digital Control (DDC)
  - Variable outputs for sophisticated environmental control
- ☐ Demand Limiting
  - Provides control of KW demand peaks
- ☐ Boiler and Chiller Reset Control
  - Maintains optimum water temperatures for facility requirements
- ☐ Zone Environmental Control with Optimized Start
  - Temperature set points scheduled and maintained on a per zone basis
  - Night setback recovery optimized to achieve comfort levels according to time of zone occupancy
- ☐ Serial 300/1200 Baud Communications and Automatic Dial-out
  - Remote programming, monitoring, report generation, and alarm message transmission
- ☐ Multi-Controller networking and host computer compatibility
  - Up to 8 units can be networked
  - Software available for IBM PC, Apple II, and CP/M compatible systems

Features:

- ☐ Time of day scheduling, 7 day programming plus holiday
- ☐ Schedulable fixed limit analog control
- ☐ Schedulable proportional limit analog control (DDC)
- ☐ Demand limiting and demand variable cycling
- ☐ Analog variable and/or schedulable duty cycling
- ☐ Optimized start and temperature control by zone
- ☐ Schedulable timed local and remote overrides (1-600 minutes)
- ☐ Night setback minimum/maximum temperature control
- ☐ Boiler and Chiller reset control
- ☐ Economizer and Enthalpy Control
- ☐ Main, First Alternate, Second Alternate, and Remote Override Programs for each channel
- ☐ Serial Communications with any terminal or computer
- ☐ Automatic Dial-Out English language alarm reporting
- ☐ Logging and report generating
- ☐ Staggered switching
- ☐ 365 day holiday programming/up to 30 dates
- ☐ Seasonal programming by date range
- ☐ Automatic leap year and standard/daylight time adjustment capability
- ☐ Rechargeable battery back-up (NICAD): 68 hours clock, minimum 200 hours program memory
- ☐ Program protected by security "lock" access code
- ☐ Automatic program entry error checking
- ☐ 1 minute resolution for all programming functions
- ☐ 1 second momentary pulse capability
- ☐ Self diagnostics check internal system operation turning all circuits ON in the event of a problem

Easy Programming/ Host Software/Networking

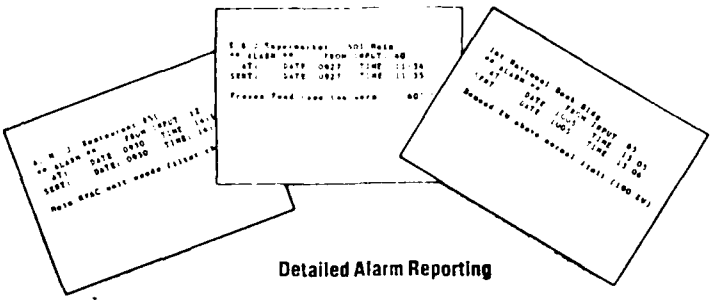
The easy, operator prompted, programming functions of the Encon 400 & 800 are identical to Encon's powerful 1600 & 3200 controllers. Programming can be performed via the front panel keyboard or any terminal or host computer. Encon's optional menu-driven host software package with English language prompting makes off-line programming possible. The Encon 400 & 800 can be utilized in large system networks along with 1600 & 3200 controllers when installed with an Encon model 128 or 256 network interface.

Unmatched Alarm Capabilities

The alarm capabilities featured in the Encon 400 & 800 are unmatched by any system in their class. These features provide the same level of sophistication and usefulness found in Encon's powerful 1600 & 3200 energy management systems.

These features include:

- ☐ Programmable alarm delay
  - Insures no false alarms
- ☐ Schedulable enable and disable times
- ☐ English language message for every alarm
- ☐ 1 Alarm for every input
- ☐ Alarm messages reported on a standard serial printer
  - No Computer required



Detailed Alarm Reporting

Specifications:

POWER REQUIREMENTS

12.5 to 14.0 volts AC, 50/60 Hz (power transformer supplied)
25 watts maximum
Dual power supply incorporates internal fuses, RFI and transient suppressors

RELAY OUTPUTS	400	800
Replaceable plug-in relays 5 amps, 24 VAC max., Form C	4	8

INPUTS		400	800
Analog	1-50 KHz frequency signal	4	8
Digital	24 VAC On or Off Signal	4	8
Demand Pulse	24 VAC Signal 5 pps Max.	4	8

PHYSICAL 400/800

Width: 12 in. (30.5 cm)
Height: 12 in. (30.5 cm)
Depth: 4 in. (10.2 cm)
Shipping Wt.: 18 lbs.
(steel enclosure with knockouts)

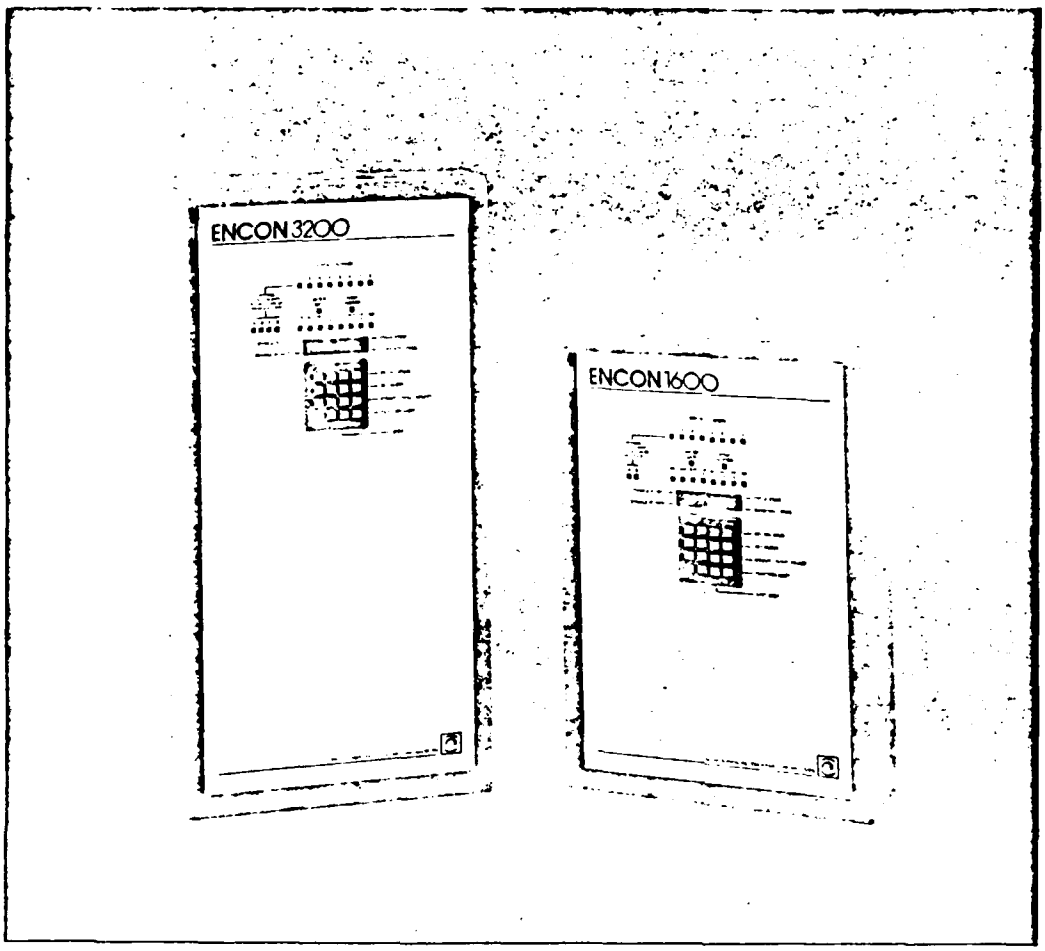
SERIAL INTERFACE

300/1200 Baud, full duplex, includes 25 pin RS-232 connector. Built-in internally powered auto-dial, auto-answer, direct connect modem available.

ENVIRONMENTAL

Operating Ambient Temperature Range 30° to 100°F
Humidity 10% to 90% non-condensing

ENCON SYSTEMS, INC.
502-F Vandell Way
Campbell CA 95008
408 866-1711
800/538-3098 (outside California)



The ENCON 1600 & 3200

Designed to meet the needs of energy management professionals in the 1980's, these powerful fifth generation additions to Encon's family of energy controllers offer a combination of extensive capabilities and advanced technology features that is unmatched by other energy controllers in their class.

Modular and Field Expandable *to fit both current* and future requirements of small, medium and even large installations, the Encon 1600 and 3200 are available at prices competitive with substantially less powerful systems.

Superior Analog Signal Transmission Technology has been designed into the Encon 1600 and 3200. All inputs are protected by opto-isolation, require only a pair of unshielded wires... and the sensors need *No Field Calibration!*

Sophisticated Control Strategies featured in these systems include:

- ☐ Analog control
- ☐ Demand limiting
- ☐ Optimized start
- ☐ Temperature variable duty cycling
- ☐ Schedulable zone environmental control
- ☐ Monitoring, data accumulation and reporting
- ☐ Automatic dial-out alarm reporting
- ☐ Boiler and chiller reset control

The Encon 3200 is available with 8-32 relay outputs, up to 32 analog measurement inputs and up to 32 digital inputs. **The Encon 1600** has the same features as the 3200, with a maximum of 16 relay outputs, 16 analog and 16 digital inputs.

Inside the ENCON 3200

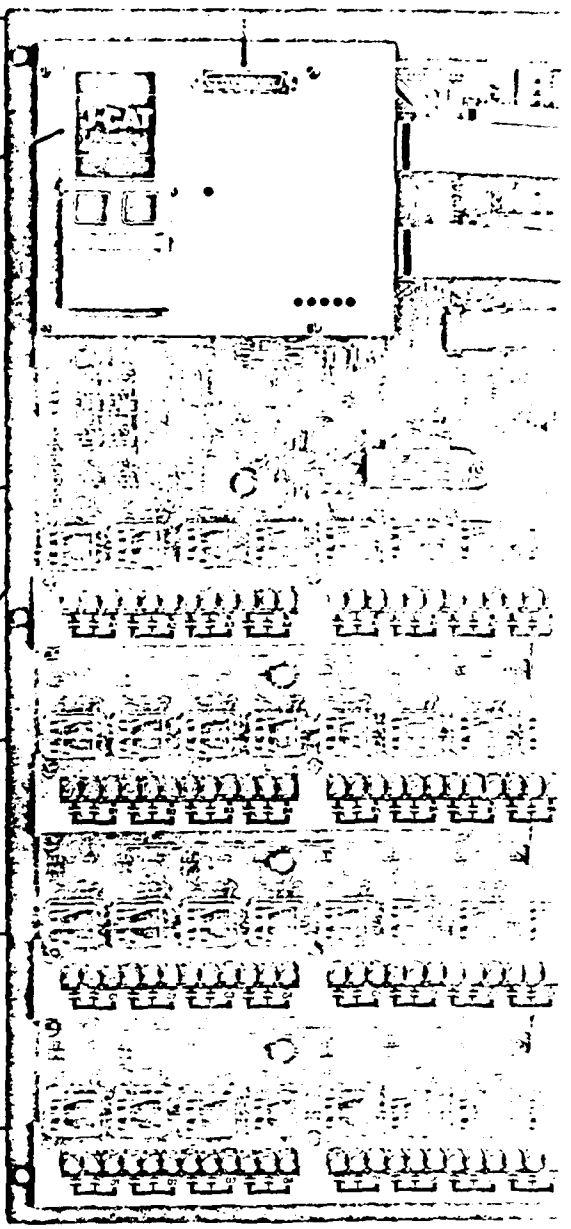
COMMUNICATIONS CAPABILITY*
Industry standard RS-232 port connects directly to any portable or stationary terminal (or computer) as an alternative to programming and interrogation via the front panel keyboard. Also connects directly to a modem for remote access.

AUTO-ANSWER MODEM† (300 BAUD)
Powered internally by the Encon 1600 and 3200, connects directly to standard telephone jack to allow programming, monitoring and accessing data to be performed remotely from any modem equipped computer or terminal.

DEMAND INPUTS* (OPTO-ISOLATED)
Accepts signals from power meter or KWH pulse transducer for demand control. Up to eight demand set points provide eight schedulable shed priority levels which allow changes during time-of-day, day-of-week, or date ranges.

RUGGED PLUG-IN OUTPUT RELAYS*
8 opto-isolated relays, with full size terminals, are provided on the main board in the 1600 and 3200. All relays are 24 VAC, 5 amp single-pole double-throw (Form C) replaceable type.

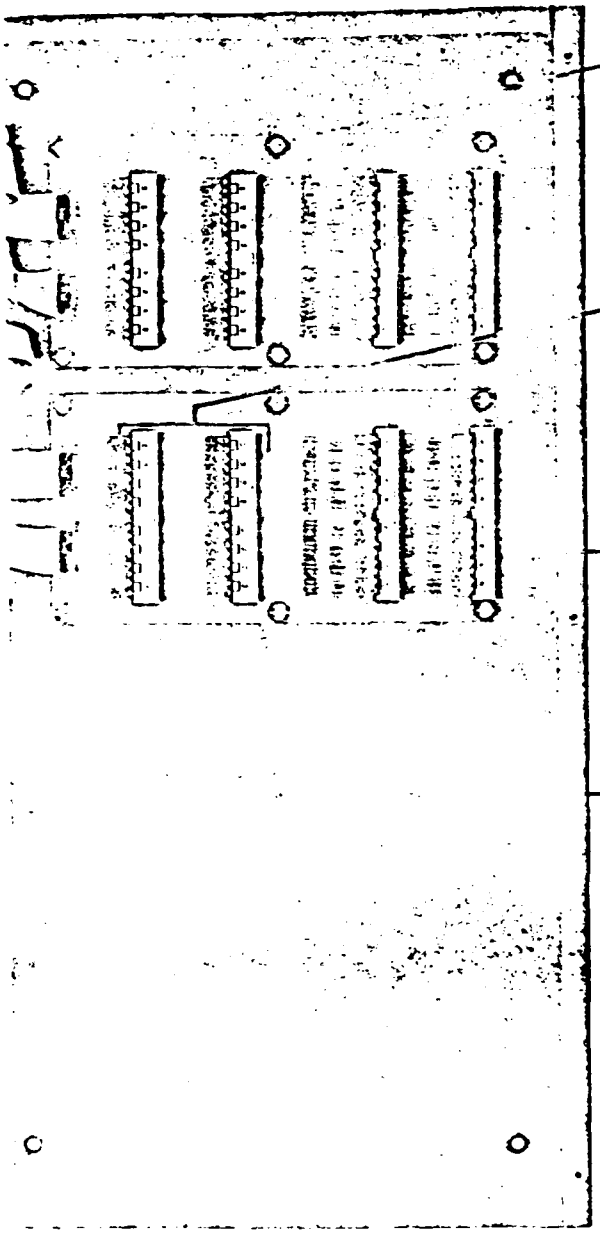
EXPANSION OUTPUT RELAY BOARDS†
Contains 8 relays and terminals identical to those on main board. The Encon 3200 accepts up to 3 additional output relay boards. The Encon 1600 accepts 1 additional board. Expansion boards are also available with 4 relays.



Advanced Control Capabilities

The Encon 1600 and 3200 controls heating, air conditioning, refrigeration, lighting, etc., according to a wide range of criteria, such as time-of-day, day-of-week, date range, analog and digital sensor inputs, Kw demand, or operator control.

The powerful microprocessor provides a high degree of programming versatility to allow the optimum mix of sophisticated control strategies. These include analog variable duty cycling, day and night zone temperature control, demand limiting, optimized start, holiday schedules, timed override programs and more. These features give the Encon 1600 and 3200 unparalleled control versatility to maximize energy savings.



ANALOG AND DIGITAL INPUT BOARDS†

Each board provides 16 analog and 16 digital inputs. The Encon 3200 accepts up to 2 boards, the Encon 1600 accepts 1 board. These boards are also available with 8 analog and 8 digital inputs.

ANALOG FREQUENCY INPUTS
(OPTO-ISOLATED)

Designed for use with a full line of 1-50 KHz analog frequency current pulse sensors for temperature, pressure, humidity, etc. Eliminates field calibration, interference problems, shielded wiring, and provides opto-isolation protection for the microprocessor

DIGITAL INPUTS
(OPTO-ISOLATED)

Designed for use with simple preset threshold sensors, remote override switches, motion sensors, or any contact closure in a 24 VAC circuit. Can be used for monitoring as well as control purposes.

ALL STEEL CABINET*

Provides ample space for easy access to all connection points

*Standard on all units
†Factory or Field Installable Option

Input Monitoring and Data Collection

The Encon 1600 and 3200 provide the information needed to monitor a building's environment and optimize its energy use.

Reports on all analog, digital, and demand inputs list the current values and historical minimum and maximum values, including time and date. These may be displayed or printed on any terminal or computer via the RS-232 port.

Other reports uniquely available on the Encon 1600 and 3200 allow detailed analysis of analog and demand set points, digital "on" conditions, and all manual override activity. For each condition the current status is reported, as well as totals for number of occurrences and elapsed time... information critical to fine tuning programs, monitoring important equipment and documenting critical events.

Superior Analog Signal Transmission Technology

The Encon 1600 and 3200 are the first energy controllers to utilize the superior characteristics of analog frequency current pulse signal transmission. Because the analog input signal varies in frequency rather than DC amplitude, data can be sent over long distances without fear of deterioration or disruption. This also permits analog input signals to be opto-isolated protecting the microprocessor circuitry from voltage spikes, static electricity charges, and other types of interference. Since the analog transmission occurs in a frequency range far above that of most electrical noise in a building, the signals are immune to interference and do not require shielded wire. That means more reliable and stable data transmission is provided at [illegible]

Features:

- ☐ Time of day scheduling, 7 day programming plus holiday
- ☐ Schedulable fixed limit analog control
- ☐ Schedulable proportional limit analog control (DDC)
- ☐ Demand limiting and demand variable cycling
- ☐ Analog variable and/or schedulable duty cycling
- ☐ Optimized start and temperature control by zone
- ☐ Schedulable timed local and remote overrides (1-600 minutes)
- ☐ Night setback minimum/maximum temperature control
- ☐ Boiler and Chiller reset control
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- ☐ Main, First Alternate, Second Alternate, and Remote Override Programs for each channel
- ☐ Serial Communications with any terminal or computer
- ☐ Automatic Dial-Out English language alarm reporting
- ☐ Logging and report generating
- ☐ Staggered switching
- ☐ 365 day holiday programming/up to 30 dates
- ☐ Seasonal programming by date range
- ☐ Automatic leap year and standard/daylight time adjustment capability
- ☐ Rechargeable battery back-up (NICAD): 68 hours clock, minimum 200 hours program memory
- ☐ Program protected by security "lock" access code
- ☐ Automatic program entry error checking
- ☐ 1 minute resolution for all programming functions
- ☐ 1 second momentary pulse capability
- ☐ Self diagnostics check internal system operation turning all circuits ON in the event of a problem

Easy Programming/ Host Software/Networking

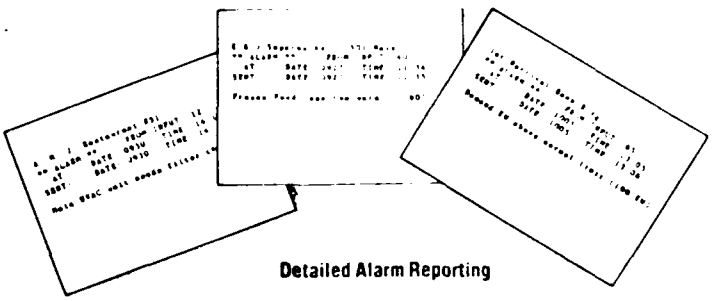
The easy, operator prompted, programming functions of the Encon 1600 & 3200 are identical to Encon's powerful 400 & 800 controllers. Programming can be performed via the front panel keyboard or any terminal or host computer. Encon's optional menu-driven host software package with English language prompting makes off line programming possible using Apple II, IBM PC and compatible systems. The Encon 1600 & 3200 can be utilized in large system networks along with 400 & 800 controllers when installed with an Encon model 128 or 256 network interface.

Unmatched Alarm Capabilities

The alarm capabilities featured in the Encon 1600 & 3200 are unmatched by any system in their class. These features provide the same level of sophistication and usefulness found in Encon's powerful 400 & 800 energy management systems.

These features include:

- ☐ Programmable alarm delay
  - Insures no false alarms
- ☐ Schedulable enable and disable times
- ☐ English language message for every alarm
- ☐ 1 Alarm for every input
- ☐ Alarm messages reported on a standard serial printer
  - No Computer required



Detailed Alarm Reporting

Specifications:

POWER REQUIREMENTS

12.5 to 14.0 volts AC, 50/60 Hz (power transformer supplied)
35 watts maximum
Dual power supply incorporates internal fuses, RFI and transient suppressors

MAXIMUM RELAY OUTPUTS	1600	3200
Replaceable plug-in relays	16	32

5 amps, 24 VAC max., Form C

MAXIMUM INPUTS		1600	3200
Analog	1-50 KHz frequency signal	16	32
Digital	24 VAC On or Off Signal	16	32
Demand Pulse	24 VAC Signal 5 pps Max	8	8

PHYSICAL	1600	3200
Width	12 in (30.5 cm)	12 in (30.5 cm
Height	18 in (45.7 cm	24 in (61.0 cm
Depth	4 in (10.2 cm)	4 in (10.2 cm
Shipping Wt	21 lbs	30 lbs

(steel enclosure with knockouts)

SERIAL INTERFACE

300/1200 Baud full duplex, includes 25 pin RS-232 connector
Built-in internally powered auto dial, auto answer direct connect modem available

ENVIRONMENTAL

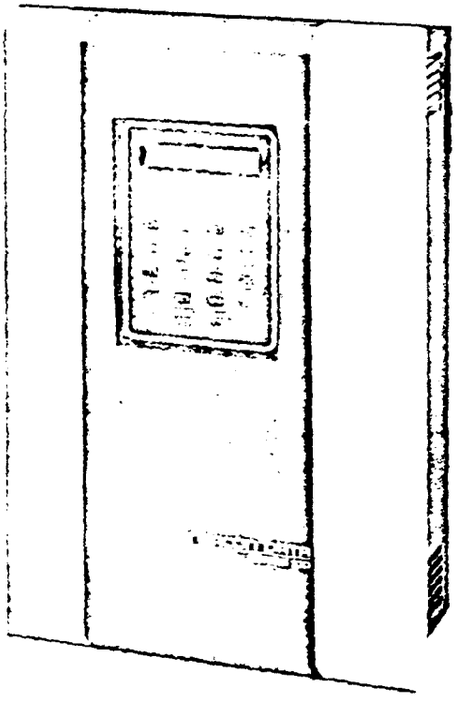
Operating Ambient Temperature Range: 30° to 100° F
Humidity 10% to 90% non-condensing

ENCON SYSTEMS INC
502 [illegible]
Campbell, CA [illegible]
408 [illegible]
800 [illegible]

ENERCON DATA CORP.

ENERGY MANAGEMENT SYSTEM 4/24

"THE SMALL BUILDING ENERGY CONTROLLER WITH BIG SYSTEM CAPABILITIES"



64 Point Capacity.

Enercon's new third generation Direct Digital Control energy management system features illuminated "Stop and Go" lights.

The programming is done through a user friendly self-prompting English language which leads the operator step by step through the program.

The Energy Management System is a flexible microprocessor-based, pre-programmed unit which can reduce energy usage by controlling devices such as fans, compressors, heaters and lighting. Available in 4, 8, 12, 16, 20 or 24 load groups, this energy management system provides sophisticated control for small buildings, utilizing *Big System Capabilities*. Modular design allows future expansion by the user as needed.

BIG SYSTEM CAPABILITIES

- English Displays
- Equipment Run Time
- Trend Logging
- Alarm Identification
- Adaptive Optimum Start/Stop

APPLICATIONS

- Department Stores
- Discount Stores
- Restaurants
- Recreational Facilities
- Schools
- Fast Food Restaurants
- Libraries
- Convenience Stores
- Banks
- Commercial Buildings
- Grocery Stores
- Office Buildings
- Shopping Centers
- Medieal Facilities
- Churches
- Public Buildings

ENERGY MANAGEMENT SYSTEM 4/24

SUMMARY OF STANDARD FEATURES

- **ALPHA NUMERIC DISPLAY**
  - English Prompting - An Alpha Numeric Display leads the operator through system programming and status checking, resulting in more meaningful data and ease of programming.
  - Load Status - Displayed as on/off with control in effect (scheduling, cycling, etc.)
  - System alarm indications.
- **EXPANDABILITY** - Input/output expansion and the addition of options can be added by the user at any time.
- **SCHEDULES** - Include up to 5 on/off pairs per day, Sunday through Saturday, plus 5 special day schedules.
- **DUPLICATE KEY** - Allows easy programming of identical loads and schedules.
- **HOLIDAYS** - Schedule up to 32 holiday periods per year in advance.
- **MINIMUM OFF TIME** - For any load control circuit and to prevent short cycles.
- **DUTY CYCLING** - Up to 5 different cycles per load per day.
- **LOAD SEQUENCING** - Loads sequence on 3 second intervals.
- **4 LOAD CONTROL CIRCUITS** - LED indicators for on/off status indication.
- **4 DIGITAL STATUS INPUTS** - For on/off indication.
- **AUTOMATIC DAYLIGHT SAVINGS AND STANDARD TIME ADJUSTMENT**
- **AUTOMATIC LEAP YEAR ADJUSTMENT**
- **90 DAY MEMORY BATTERY BACKUP**
- **TACTILE AND AUDIO FEEDBACK KEYBOARD**
- **AUDIBLE/VISUAL ALARM ANNUNCIATOR**
- **9 SYSTEM ALARMS**
- **POWERED BY 24 VOLT AC POWER**
- **LOCKABLE ENCLOSURE**

ENERGY MANAGEMENT SYSTEM 4/24

- **TELEPHONE COMMUNICATIONS** - Two way capability over voice grade phone lines, provides for reporting system status, collecting historical data and altering system control parameters.
  - Auto call mode
  - Auto dial-out mode to report alarms
- **DEMAND MONITORING AND CONTROL**
  - Sliding window predictive method
  - Up to 4 meter inputs
  - Up to 5 demand targets
  - 5 priority levels
  - Floating target
  - Maximum shed time
  - Minimum "on" time
- **LOADS** - Up to 24, in groups of 4
- **ADAPTIVE OPTIMIZED START AND STOP**
- **DIGITAL STATUS INPUTS** - Expandable to 20 in groups of 4
- **SWITCHED TIMED OVERRIDE** - Allows after hours occupancy
- **EQUIPMENT RUN TIME** - Will accumulate "on" time of load control circuits and digital status inputs.
- **ANALOG INPUTS** - Up to 20 available
  - 16 RTD temperature inputs in groups of 8
  - Four 4-20 milliamp sensors in one group of 4
- **TEMPERATURE COMPENSATED DUTY CYCLING WITH ADJUSTABLE DEAD BAND**
  Duty cycle time is varied by temperature. The space temperature limits (high low) and dead band are entered for each load
  - Occupied/unoccupied temperature control
  - Temperature overrides
- **ALARM EXPANSION** - Digital status, temperature inputs or analog inputs can be used in alarms, up to a total of 55. Displays last alarm, time of occurrence, duration, current alarm status
- **TREND LOGGING** - Operator may select one or more of analog or temperature points for hourly trend logging of maximum and minimum values for the last 30 hours. Points not selected will be trend logged for their daily maximum and minimum values and associated times for the last 30 days. Daily power consumption along with daily peaks and times of occurrence are stored for last 30 days.
- **AUTOMATIC DEGREE DAY CALCULATION** - Both heating and cooling degree days are logged for last 30 days.

ENERGY MANAGEMENT SYSTEM 4/24

SPECIFICATIONS:

ENVIRONMENTAL

Operating and Storage	Temperature: 32° to 122°F (0° to 50°C) Humidity: 0% to 90% RH (non-condensing)

PHYSICAL

Enclosure	Sheet steel 18 gauge
Size	12"w x 18"h x 5½"d (30.48 cm x 45.72 cm x 13.97 cm)
Weight	15 lbs. (6.75 kg.)

ELECTRICAL

Input Voltage	24 VAC ± 10% 50-60 Hz
Power Consumption	13 watts typical
Conduit Knockouts	Bottom of enclosure
Battery Backup	Lithium chloride battery (90 days)
Load Wiring	Barrier strips, 2 terminals for each of 24 circuit outputs; wire 14-24 gauge

Local Sales & Service Office

ENERCON DATA CORPORATION
CORPORATE OFFICE
7464 METRO BLVD. MINNEAPOLIS, MN. 55435
612-829-1900 / 800-328-1845

ENERGY MANAGEMENT CORPORATION

The EMS-Z Series, the solution to your energy management problems– both large and small...

Good Business Sense

Few people would argue the fact that, in order to remain profitable and competitive, a business must be *carefully* managed. Companies generate annual plans designed to increase their productivity and profitability. Yet without a well thought-out energy management program, a company can waste thousands of dollars on energy inefficiency.

Energy costs are no longer directly related to wellhead oil prices. Oil barrel costs have continued to decrease while energy costs have steadily increased. The spiraling upward costs for constructing nuclear power generating facilities are passed on to the consumer — *you!*

In fact, energy experts project an annual 6% *increase* in the cost of energy, without taking into account annual inflation. If yearly inflation were held to only 4%, your energy costs would increase by *10%* — a significant amount, indeed! Quite simply, *energy management makes good business sense!*

Energy Management Corporation

Energy Management Corporation was founded in 1974 and is now a subsidiary of General Instrument Corporation, a 65 year old Fortune 500 company. The reliable, flexible management systems that we manufacture are the result of our more than 10 years of diversified energy management experience. EMC has an established reputation for quality and innovation.

EMS-Z Series Product Features

The EMS-Z facilities management system is a stand-alone microprocessor that uses non-volatile memory chips for its software and data base programming. The system's programming is retained during power outages, eliminating the need for battery backup.

The EMS-Z controls lighting, environment, and refrigeration to *your* standards and provides detailed maintenance and management information. Among the system's variety of control capabilities and strategies are direct digital control, total point-to-point referencing, optimized start/stop, dynamic load shedding and duty cycling, relative store hour base scheduling, multiple prioritized alarming, a unique refrigeration control algorithm, and the NC10 Network Controller for two-wire common bus interface. System security requires the keying-in of an alpha/numeric password to gain system access. Multiple authorization levels are also available.

The EMS-Z is easily field upgraded to grow and change along with your operation. EMC delivers tomorrow's system tailored to meet today's needs.

EMS-Z30 Configurations

EMS-Z30/31 (16 digital outputs/ 16 analog inputs/ 16 digital inputs)

EMS-Z30/32 (32 digital outputs/ 32 analog inputs/ 32 digital inputs)

Optional 1200/300 Baud Selectable Modem for Auto-Answer/Auto-Dial Over Voice-Grade Telephone Lines

Optional 76 Remote Display (4 Lines x 32 Character LCD) for On-Sight Access to System Data

Optional Bubble for additional 128K non-volatile memory

EMS-Z30 Specifications

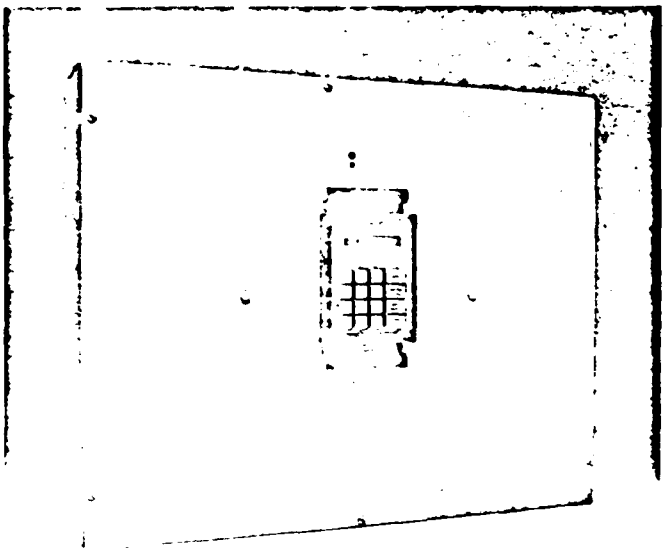
Cabinet Dimensions	24"x17"x9" (WxHxD)
Weight	36 lbs
Shipping Weight	45 lbs
Operating Temperature Range	0 F-100 F
Relative Humidity (Non-Condensing)	0%-95%
Voltage Range	95VAC-135VAC
Frequency Range	47Hz-450Hz
Current Rating	3A @ 115 VAC
Power Supply	+5V @ 6A
	+12V @ 1A
	+12V @ 2.5A
	12V @ 1A

Energy Management Corporation

Subsidiary of
GENERAL INSTRUMENT CORPORATION
9 Schilling Road
Hunt Valley, Maryland 21031
301-683-3500

GENERAL ELECTRIC

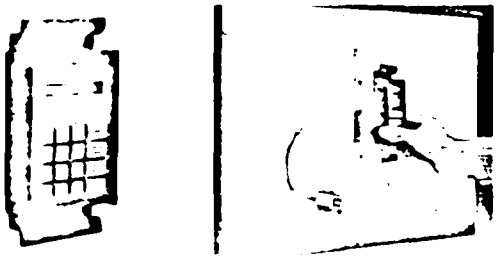
SMART REMOTE CONTROL



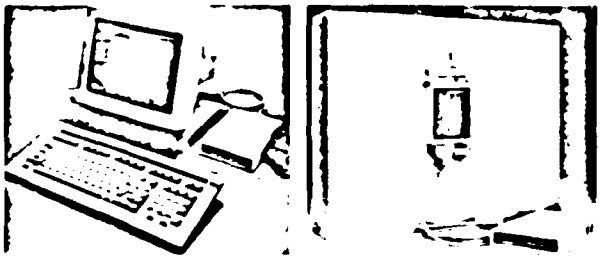
▲ Relay panel assembly with portable programming module

Plug in intelligence modules provide programmable switches and relay scheduling ▶

Portable programming module ▼



▼ CRT based telecommunications option for remote programming



Low Cost Lighting Automation Panels

Smart Remote Control (SRC) consists of standalone, intelligent relay panels which provide the inherent switching flexibility of Remote Control while eliminating the need for custom control circuits and external scheduling devices. The intelligence for each panel resides in two plug-in cards: a Control Module with 32 relay output capability and a Switch Input Module with 16 programmable inputs. This intelligence provides the most critical functions required for effective lighting control more efficiently than lighting contactors linked to an energy management system or timelocks, and it does so at competitive costs.

Wiring Flexibility

Programmable Switches

Any number of switches may be connected to a switch input which in turn may be programmed to control any group of relays in that panel. For instance, an occupant's switch can be programmed to control the lighting relays for his area. In addition, a master switch can be programmed to control all of the lighting relays on the floor, including those controlled by each occupant switch. If the circuits to be controlled by any switch should change, no rewiring is required; instead, the switch definition would simply be reprogrammed to reflect the change.

A single switch may also be used to control relays in several panels. This allows a single master switch to be programmed to control selected lighting circuits throughout the building.

Low Voltage Control Wiring

All switchlegs use inexpensive low voltage wiring which also reduces the risk of shock and fire.

Pilot Light Indication

Relays may be supplied with pilot contacts which allow central pilot light indication of the lighting status.

Energy Savings

The on-board intelligence also allows each relay to be independently scheduled. This allows the lighting levels to be scheduled in each area based on normal occupancy. In addition, photoswitches can be readily added to allow circuits to be shed in perimeter zones when adequate daylighting is available. Switches for the cleaning crew can also be programmed to control only selected circuits. These functions provide the bulk of the energy savings available in many installations.

Occupant Sensitivity

Individual occupant switches may be used to override lighting turned OFF by the automatic schedule. A programmable time delay feature allows each occupant to be given a timed override of 2-250 minutes. Simply pressing the switch ON anytime during the delay will restart the timing cycle.

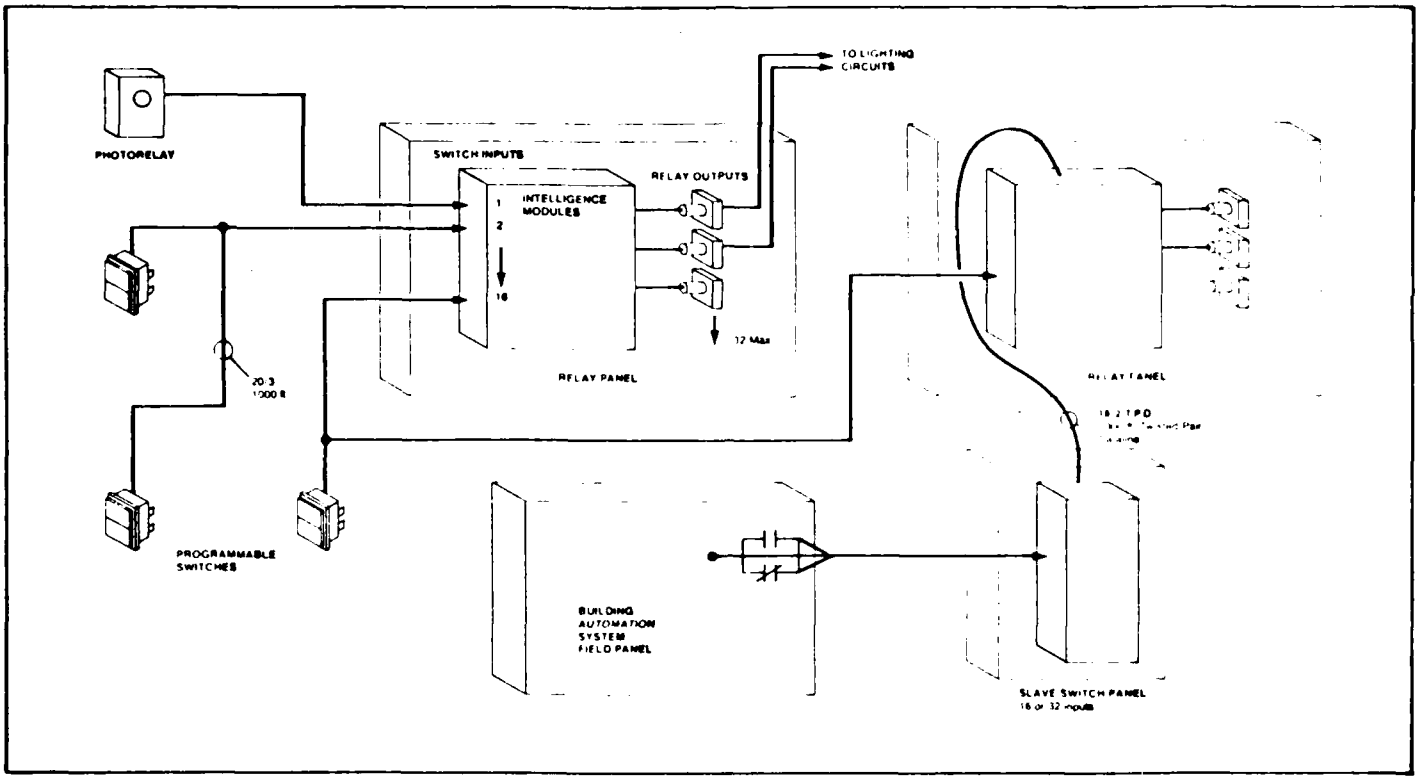
Intelligent Building Systems Integration

The programmable switch inputs in each panel may be directly interfaced to the output contacts of most external control systems. This allows these systems to readily control selected lighting circuits within each panel.

Multiple Facility Control

Each SRC panel may be equipped with telecommunications capability allowing it to be programmed, controlled, and monitored from a remote location.

CONFIGURATION



Installation
The fully assembled, tested relay panel is mounted in the electrical closet. The numbered relays are wired in series with the circuit breaker controlling the lighting circuit. The local switches are wired to numbered switch input terminations.

Programming
Each panel may be programmed locally with a portable programming module or remotely with a CRT using telecommunications.

The user data and internal clock in each panel have an internal power backup with a minimum holdup time of four days. No battery replacement is required.

Maintenance
In the event of a failure, the plug-in intelligence cards can be removed and replaced in minutes without turning the lighting OFF on the floor.

Upgradability
SRC panel can be readily upgraded to Programmable Lighting Control. The Control module is simply replaced with a PLC Output module and a single twisted pair data line added for the communications link to a PLC central controller.

KEY FEATURES/BENEFITS

20 amp, 277 VAC Latching Relay
Stable, positive operation, latches to last position actuated, retains position during power outages.
No power consumption during normal operation; momentary power required only during change of state.

Low Voltage Control Wiring
Small, low voltage control wiring reduces the cost of long switchlegs.
Low energy power reduces the danger of shock and fire.

Fully programmable switch operation
Any switch controls any group of relays.
2-250 minute timedelay option by switch.

365 day scheduling
15 holidays programmable 1 year in advance.
1 minute resolution.

Password protection on program data

Internal power backup
Requires no maintenance or battery replacement.

Plug-in intelligence modules, relays, switches
Easy maintenance.

Telecommunications
Remote programming, display, control via standard dial-up telephone lines.

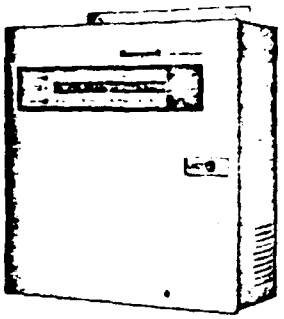
Simple Upgrade to Programmable Lighting Control
Protected investment.

For more information see GEA11594.

HONEYWELL, INC.

W7000 Series II System

The W7000 Series II can be used alone or with multiple options and peripheral devices to provide a wide range of functions and sophistication. The various system components are explained on the following pages with block diagrams illustrating how each fits into the system. W7000 Series II with all available options and peripherals is illustrated on page 176.



W7010/20E,G,H and W7040H Load Control Systems

Microprocessor-based load control system for automated building energy management.

The W7000 Series II Load Control Systems reduce energy costs by limiting kilowatt (kW) demand and lowering energy (kWh & Btu) consumption using 4 energy management functions: Time-of-Day (TOD), Optimum Start/Stop (OSS), Demand Limit Control (DLC), and Temperature Dependent Duty Cycling (DC). TOD control reduces kWh consumption by turning loads on and off according to a user-entered program based on time of day. Optimum Start/Stop reduces kWh consumption by working with TOD to turn HVAC loads on and off. OSS calculates the latest time to turn HVAC loads on before occupancy (Optimum Start) and the earliest time to turn loads off before the end of occupancy (Optimum Stop). Demand Limit Control monitors kW demand and automatically sheds and restores loads according to a user-entered program that maintains peak demand below a preset level. Temperature Dependent Duty Cycling reduces kWh consumption by controlling loads based on temperature according to a user-entered program. The duty cycle is varied continuously with temperature.

The W7000 Series II contains an internal Power Line Carrier (PLC) multiplexer. This allows the W7000 to be connected directly to a PLC transmitter which sends ON/OFF control signals over existing building wiring, eliminating the need for extensive control wiring (see page 206 for PLC).

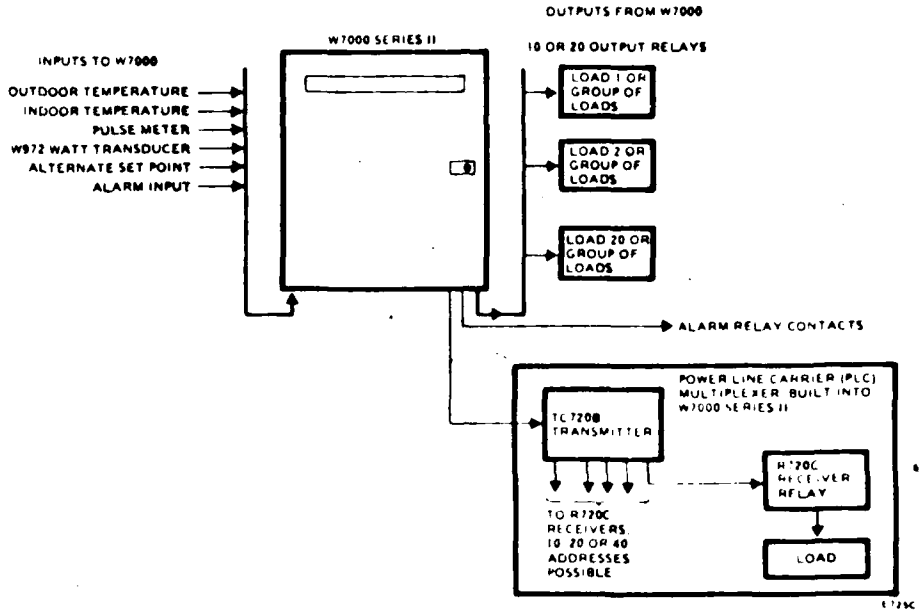
The numerous auxiliary functions in the W7000 Series II serve to automate building operations and simplify W7000 installation and operation. These auxiliary functions include: 365-day clock with automatic adjustment for daylight-saving time and leap years; 3 different holiday schedules; TOD Bypass, Forced ON/OFF and Bypass switches for override capability; continuous LED display for kW, date and time; simple prompted programming; self-recharging battery backup; malfunction diagnostics, and a 2-digit programming access code. The W7000 Series II is available in 10-, 20-, and 40-channel models.

Multiple options and peripherals are available to enhance the operation of the W7000 Series II System. These include: Q7000 Communication Module (page 168) for telephone communication and data storage; RAMP II (Remote Access Monitoring Program) software package for personal computers (page 170); W7025 Data Processing Panel (page 171) for 20 additional temperature inputs; and the S7400 System Interface and Monitor (page 173) which connects the W7000 to the T7400/W7400 Programmable Commercial Thermostat, monitors equipment run time, number of cycles, and provides 2 alarm inputs.

Dimensions (all W7000 Series II models): 19-3/16 in. [487 mm] (with mounting bracket) high, 16-1/8 in. [410 mm] wide, 6-3/4 in. [172 mm] deep. Listed by Underwriters Laboratories Inc.; Canadian Standards Association certified.

continued next page

W7010/20E,G,H and W7040H continued



W7000 Stand-alone Functions

—Models available for control of 10,20 and 40 loads or groups of loads.
—Time-of-Day Programming.
—Optimum Start/Stop.
—Temperature Dependent Duty Cycling.
—Demand Limit Control with multiple set points and programmable MIN. ON, MIN. OFF times.
—Automatic calculation of calendar changes for daylight-saving time and leap years.
—Three different holiday schedules with 25 programmable holiday dates.
—Time-of-Day Bypass and Forced On-Off—both channel selectable.
—Two temperature inputs.
—LED display provides visual indication of all system parameters including kW set point, date, and time.
—Prompted programming for simple program entry.
—Self-recharging Nicad battery backup.
—kW and kWh history.
—Accepts kW input from watt transducer or pulse meter.
—Alarm input.
—Extensive malfunction diagnostics.
—Selectable 2-digit access code to prevent unauthorized programming.
—Locking cover.
—Power Line Carrier (PLC) multiplexer is built into the W7000 Series II, provides PLC control of 10, 20, or 40 receiver addresses.

ELECTRICAL RATINGS:
Power Input—120 Vac, 60 Hz.
Maximum Power Consumption—80 W.
TEMPERATURE RANGES:
Operating—32 F to 122 F [0 C to 50 C].

W7000 SERIES II MODELS AVAILABLE:
Available only through Authorized Honeywell Energy Management Distributors.

continued next page

W7010/20E,G,H and W7040H continued

Order Number	Demand Limit	Duty Cycle	Time-of-Day Programming	Optimum Start/Stop	Number of Channels
W7010E1046		X	X		10
W7010G1042	X	X	X		10
W7010H1008	X	X	X	X	10
W7020E1044		X	X		20
W7020G1040	X	X	X		20
W7020H1006	X	X	X	X	20
W7040H1002	X	X	X	X	40*

*20 channels may be hard wired or PLC, the other 20 channels are PLC only

Additional equipment, accessories, and parts available only through Authorized Honeywell Energy Management Distributors

AVAILABLE ACCESSORIES

W972B1000 Watt Transducer Converts signal from service voltage and CT s (current transformers) to a 0-100 mV signal proportional to building kW Used as demand input to W7000

C5001 Current Transformers (CT)

Donut type—

C5001A1001 400 5 ratio
C5001A1019 800:5 ratio
C5001A1027 1200 5 ratio

Split Core type

C5001B1009 400/800/1200 5 ratio
C5001B1025 800/1200/1600 5 ratio
C5001B1017 1600/2000/2400 5 ratio

Q7000A1029 Communication Module

—S70002A1007 Data Access Arrangement (DAA) Bell 103 Compatible
—194810A RS232 Compatible Cable

ZA7002 RAMP II—for use with personal computers Automatically telephones installed W7000's and recalls Q7000 data Saves manipulates, edits, and formats data for reporting and monitoring purposes

W7025A1006 Data Processing Panel (DPP) Provides 20 additional temperature inputs to the W7000 Series II for OSS, DC, temperature monitoring and alarming

S7400A1005 System Interface and Monitor (SIM) Interfaces W7000 to T7400 W7400 Programmable Commercial Thermostat System Provides alarm contact inputs and event monitoring inputs which are logged by the Q7000 Communication Module for equipment diagnostics

W7026A1005 Junction Panel RS422 Junction Panel for use with the W7000 Series II System

T7400/W7400 Programmable Commercial Thermostat System

(Consult T7400, W7400 specification sheet, form 63-2013 for detailed and complete ordering information.)

Power Line Carrier (PLC) System

- TC720B1004 (120 Vac), and TC720B1020 (240 Vac) Transmitters accept multiplexed control signals and transmit control signals across existing building wiring
- R720C1009 (120, 208, 240, 277 Vac), and
—R720C1017 (480 Vac) Receiver Relays detect transmitter signals over existing building wiring and control connected loads ON or OFF

Bypass Switch Option

- 194639E W7010 Bypass Switch Option
- 194639F W7020 Bypass Switch Option

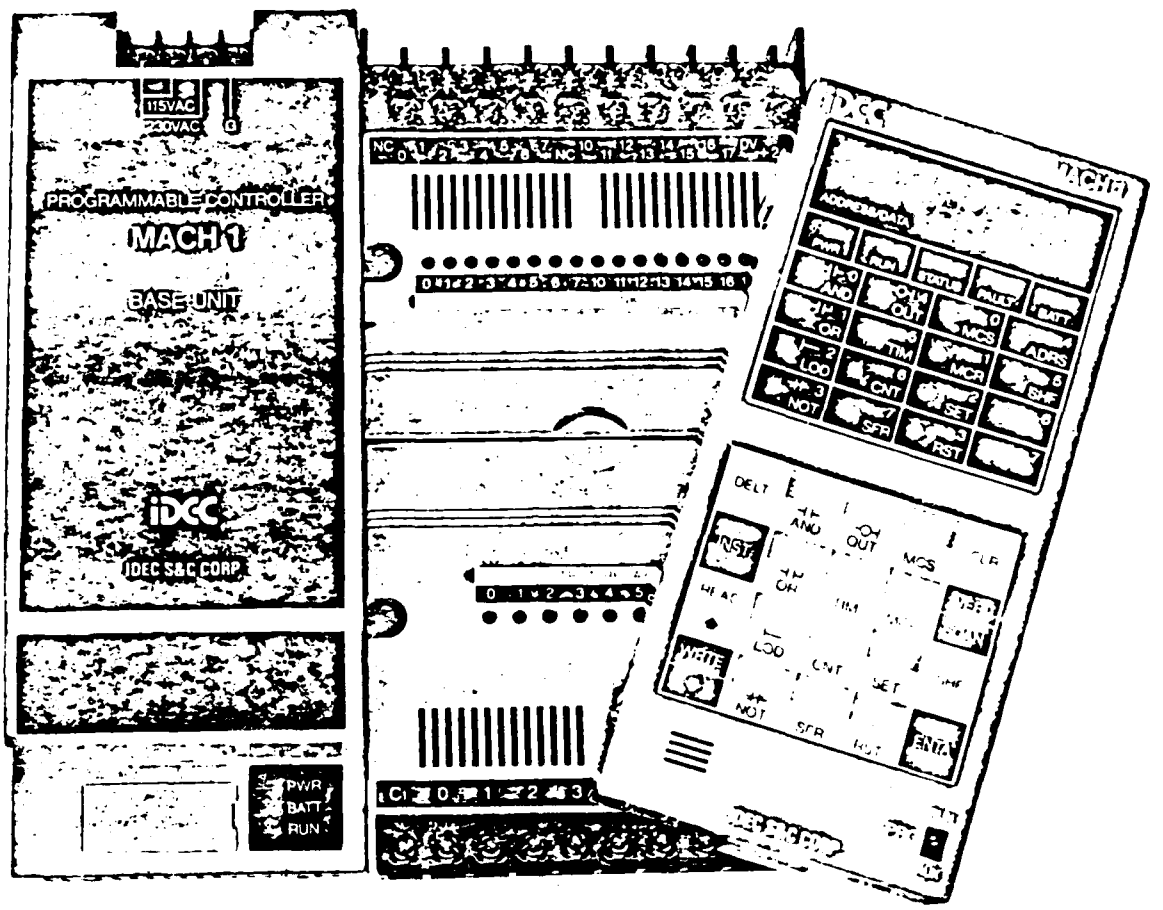
Solid State Temperature Sensors

- 194950B regular accuracy +/- 4 F [2.2]
- 194950E high accuracy +/- 2 F [1.1 C]

IDEC SYSTEMS & CONTROLS CORPORATION

MACH 1

IDEC's New Low-Cost Micro PC.



The Mach 1 is a compact, low-cost micro programmable controller designed to meet the requirements of a broad variety of applications.

The right size in low profile styling, the Mach 1 will conserve panel space and trim control expense with the use of smaller, lower cost panels.

Available in 8 or 16 inputs and 8 or 16 outputs the Mach 1 offers flexibility, quality and economy.

Input modules are available in 120V AC and 24V DC. DC input modules are available in sink or source type.

Mach 1 output modules are available with 5 amp contact relays, solid state relays or transistors.

The CPU contains a powerful executive program including 700 words of user memory, 184 internal relays (56 are retentive), 20 timers/counters, 8 special internal relays, and shift registers.

Diagnostics include CPU error, memory error, syntax error and battery NG.

A detachable program loader is provided to write user programs. The loader is equipped with 12 basic instruction words, 3 position switch for run, program and auxiliary, and an auxiliary jack for program storage. The display is large and bright using LED's to indicate data and function.

Some applications are

- Elevators
- Conveyors
- Pump control
- Strapping machines
- Motor sequencing
- Animation and advertising
- Machine control
- Alarm systems
- Theatrical lighting
- Vending machines

IDEC
SYSTEMS & CONTROLS
CORPORATION
1213 ELKO DRIVE
SUNNYVALE, CA 94089-2211
(800) 538-8098 (408) 747-0550

SPECIFICATIONS

General Specifications

Power Voltage	120V-240V AC +10 to −15%
Storage Temperature	−10 to 70°C
Operating Temperature	0 to 60°C
Operating Humidity	5 to 95%
Dielectric Strength	AC1500V for 1 minute
Insulation Resistance	20MΩ min., 500V DC
Vibration Resistance	Conforms to J1S C0911 IIB — Class 3 (16 7Hz, 3mm)
Shock Resistance	Conforms to J1S C0912 (10G)

Function Specifications

Control System	Stored program
Program Method	Logic symbol
Instruction Words	12 basic instructions
Program Size	700 words
Memory Type	CMOS RAM
Scan Time	20ms average (500 words)
I/O Points	
Input	8 or 16
Output	8 or 16
Internal Relays	184 points (56 points are retentive)
Special Internal Relays	8 points
Shift Register	128 points max
Timers/Counters	20 points timer (0.1s-999.9s) counter (1-9999)
Diagnostics	CPU error, program error, syntax error, Battery NG
External Input Control	Run/Stop

I/O Specifications

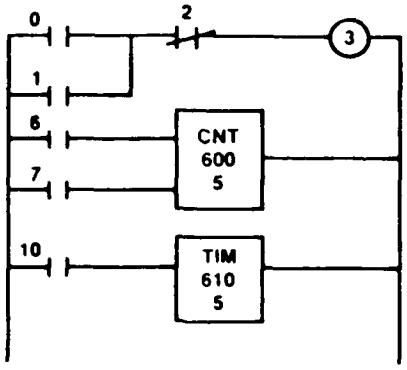
AC Input	8 points per module
Voltage	120V 50/60Hz, +10 to −15%
ON	96V
OFF	24V
Impedance	12KΩ
Current	10mA
DC Input	8 or 16 points per module
Voltage	24V
Polarity	sink or source
ON	14.4V
OFF	7.2V
Impedance	2.4K
Current	10mA
Relay Output	8 points per module
Contact	SPST (NO), Silver Nickel
Maxload	5A 120V AC 30V DC
Minload	100mA 5V
*SSR Output	8 points per module
*Transistor Output	8 or 16 points per module

*Available mid-1986

INSTRUCTION WORDS

Symbol	Name	Description
LOAD	LOAD	Start a line of logic
AND	AND	Logic AND (series circuit)
OR	OR	Logic OR (parallel circuit)
OUT	OUTPUT	Coil-end of line of logic
NOT	NOT	Inverted logic (normally closed)
MCS	Master Control Set	Starts master control
MCR	Master Control Reset	Ends master control
TIM	TIMER	Delay on or delay off
CNT	Counter	Counter
SFR	Shift Register	Shift register
SET	SET	Set internal or out relay
RST	RESET	Reset internal or output relay

PROGRAMMING EXAMPLE

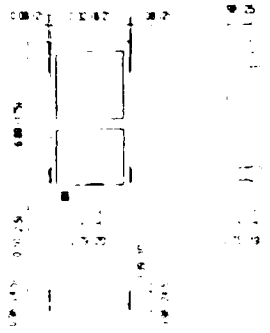


LOAD	0
OR	1
AND NOT	2
OUT	3
LOD	6
LOD	7
CNT	600
	5
LOD	10
TIM	610
	50

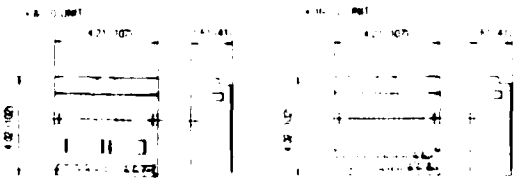
EXTERNAL DIMENSIONS

• **CPU Unit**

• **Detachable Hand Loader**



• **I/O Module**



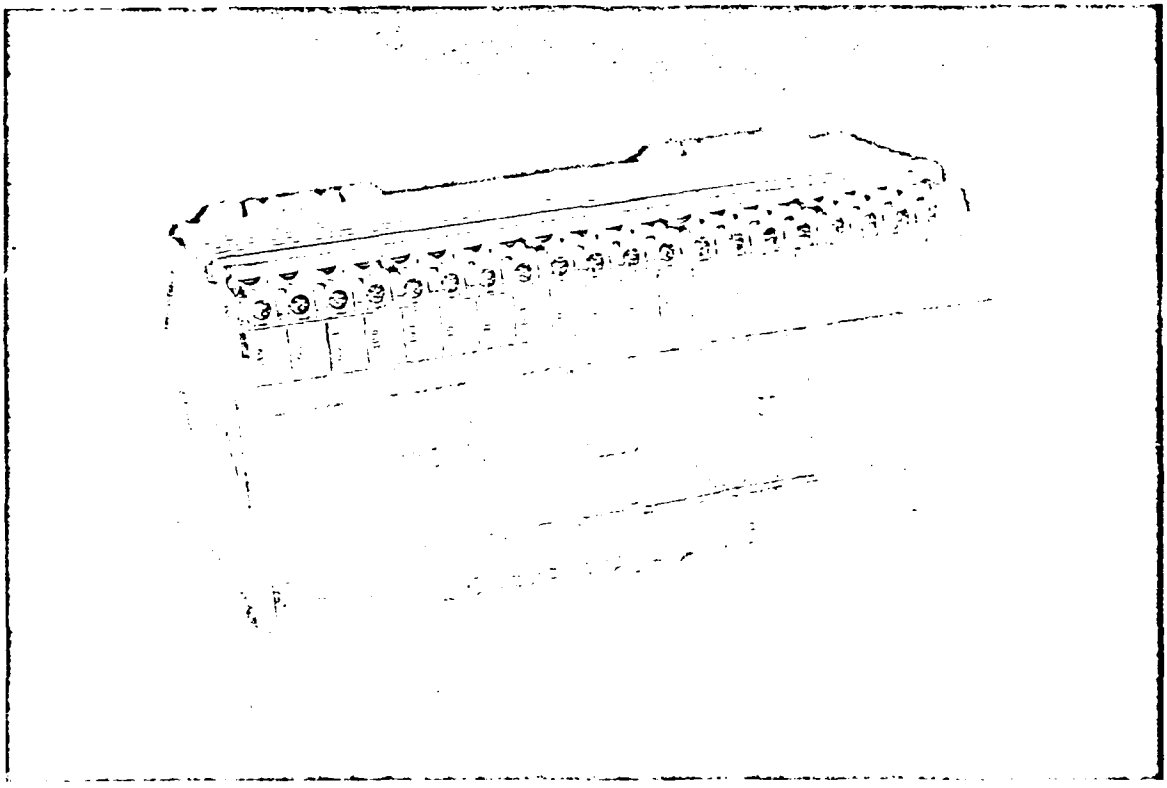
(Unit: mm)

KLOCKNER MOELLER CORPORATION

Klockner MOELLER

PS3

Micro Programmable Controller



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PS3 MICRO PROGRAMMABLE CONTROLLERS

12 KEY FEATURES

- Analog inputs/outputs
- Real-time clock (including 32 alarm signals)
- High-speed input (10kHz)
- De-centralized operation
- Modular expansion capability
- Arithmetic functions +, −, ×, ÷
- DIN rail mounted
- Capability to connect to another programmable controller or computer
- Hand-held programmer
- Light-pen programmer
- Comprehensive library of software modules
- Programmable timers

KLOCKNER-MOELLER has developed a compact, rugged, low cost, programmable controller PS3.

Bearing in mind the variety of functions required of modern control systems, the highly efficient PS3 has a unit extension facility. Its analog input/output capability makes it ideal for closed loop controls—previously the exclusive domain of larger programmable controllers—and permit its use as a decentralized unit for the PS 32. This, coupled with the comprehensive software library which the microprocessor offers, makes the PS3 suitable for machine controls of low to medium complexity.

Its high speed input (10 kHz) and powerful arithmetic functions +, −, ×, ÷, embodies the complete solution for high speed counting.

Communication with a computer/programmer is an essential requirement of any PC system. Having two RS 485 interface ports, the PS3 can be programmed via a hand held programmer (PRG 3), a light-pen programmer (using the PRG 300) or with any IBM-PC or compatible unit.

		PS3-DC	PS3-AC	PS3-8
1	Worldwide customer service	Yes	Yes	Yes
2	Cap dimensions for service distribution boards	Yes	Yes	Yes
3	Digital inputs	16 x 24 V d.c.	16 x 24 V d.c.	8 x 24 V d.c.
	outputs	16 x 24 V transistor	8 x 240 V/2 A/relay	8 x 240 V/2 A/relay
4	Analog inputs	4 x 0 - 10 V	4 x 0 - 10 V	—
	outputs	1 x 0 - 10 V	1 x 0 - 10 V	—
5	High-speed counter input	1 x 10 kHz	1 x 10 kHz	—
6	Power supply	24 V d.c	110/240 V a.c.	110/240 V a.c.
7	Real-time clock	Yes	Yes	–
8	Cycle time for 1000 addresses	Typically 2 ms	Typically 2 ms	Typically 2 ms
9	Program modules: Timers, Counters, Shift registers, Comparators	Each with 32	Each with 32	Each with 32
10	Arithmetic functions: +, −, ×, ÷	Yes	Yes	Yes
	Programming			
11	With PRG 3 hand-held programmer	Instruction set		
12	With PRG 300 light pen programmer (also for documentation)	Instruction set Ladder diagram		
13	With IBM-PC or compatible device (also for documentation)	Instruction set Ladder diagram		
	System combinations			
14	PS3 ◄——► PS3	Maximum four units Each unit can be used as basic unit or expansion unit Field bus interface cable, 3-core, screened Length of field bus up to 600 m		
15	PS 32 ◄——► PS3 IBM-PC ◄——► PS3 Klockner-Moeller PS 32 programmable controller	Maximum 32 units can be used as decentralized remote I/O Field bus interface cable, 3-core, shielded Length of field bus up to 600 m		
16	Dimensions Width 215mm Height 100mm Depth 135mm			

Model	Price
PS3-8	
PS3-D C.	
PS3 A C.	
PRG3	
SIM PS3	

Klockner-Moeller Corporation
Corporate Office
4 Strathmore Road, Natick, MA 01760
(617) 655-1910 Telex: 94-8434 Telefax: (617) 655-276

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MCC POWERS

System 600 Stand-Alone Control Unit (SCU)

An integral part of the System 600 Stand-alone Energy Management System, the Stand-alone Control Unit (SCU) utilizes the functionality of Distributed Digital Control (DDC) to perform basic temperature control in addition to energy management. Each SCU can operate as a truly independent control panel. Or, many SCU's can be wired together to form a local network in which the panels can communicate point information or control instructions with each other without a host Central Processing Unit (CPU).

The heart of SCU is the controller board which contains multiple processors and allows the SCU to accomplish tasks, such as:

- Define the system hardware configuration, control logic and other parameters necessary for the successful management of the building control system.
- Full Proportional-Integral-Derivative control of HVAC systems minimizes offset and maintains tighter control to assigned setpoint.
- Monitor system operation and control the building environment, thus ensuring occupant comfort.
- Provide the user with the capability of exercising operator control over the System 600, such as altering setpoints, switching control modes, displaying point status, controlling motors.
- Diagnose system malfunctions or equipment failures.
- Execute energy management application programs.
- Local Man-Machine Interface (MMI) and systems communication support.

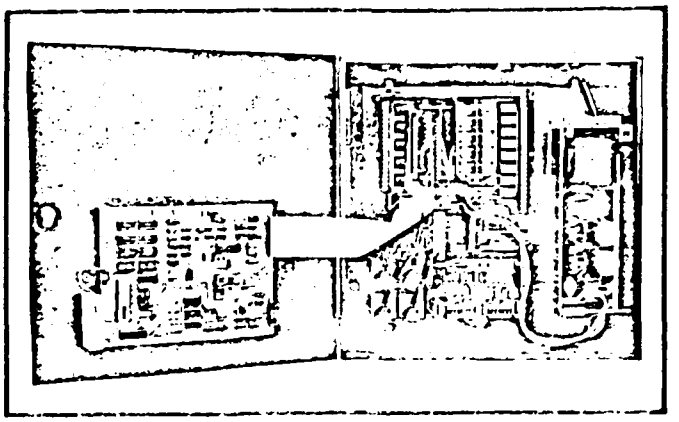
The communication board provides the versatility for the SCU. It allows the SCU to:

- Communicate and share data with other SCUs on the network without a CPU.
- Communicate with point extension modules, such as the Digital Point Unit (DPU) and the Multiple Point Unit (MPU).
- Communicate with SCUs in remote locations over publicly switched phone lines by using the Telecommunications Interface Unit (TIU).

Energy Management Applications

Operating alone or as part of a network of panels, the SCU can also provide the following energy management programs without a host CPU.

- peak demand limiting
- enthalpy changeover
- time of day scheduling
- duty cycling
- start-stop time optimization
- night setback
- economizer cycle
- holiday schedule



System 600 Stand-Alone Control Unit (SCU)

Features

- Allows user to add, delete, or change points without vendor assistance.
- Allows user to write custom control sequences without vendor assistance.
- Uses MCC Powers proven DDC architecture.
- Provides temperature control and energy management from an independent control panel.
- Shares information system-wide via the SCUs network without the use of a CPU.
- Allows the use of publicly switched phone lines in systems communicating with buildings in remote locations.
- Allows user to economically monitor remotely located equipment through the use of point extension modules.
- Provides for system expansion when needed. Additional points or system functions can be integrated into the existing system without obsoleting the present system hardware.
- Communicates in conversational English point names.
- Provides power-fail operation with 8 hour memory battery back-up and manual program reload should memory be lost.

Expansion of System 600

Compatible with System 600 family products, SCUs and Remote Control Units (RCUs) can be connected to the same trunk. An SCU network can be easily upgraded to any one of the Digital Equipment Corporation (DEC) host CPUs* or the IBM Personal Computer (PC). After revising software at existing System 600 sites, SCUs can be added to prior System 600 installations.

*Computer must have 512 KB of main memory.

Order No. 149-042

Form HA 1931-1
Printed in U.S.A. 4-85

System 600—Portable Operator's Terminal

The System 600 Stand-Alone Control Unit (SCU) supports a full feature portable operator's terminal. Using this terminal the system operator may perform any of the following functions, without vendor assistance.

Point Commands:
- Display the status of any point
- Change setpoints
- Command points on or off
- Enable or disable existing points

Reports:
- Status of all points in system
- All failed points
- All points being trended
- All points being totalized
- Command priority of all points
- All points in alarm status

Data Base Entry:
- Add a new point
- Modify an existing point
- Remove an existing point
- Copy an existing point

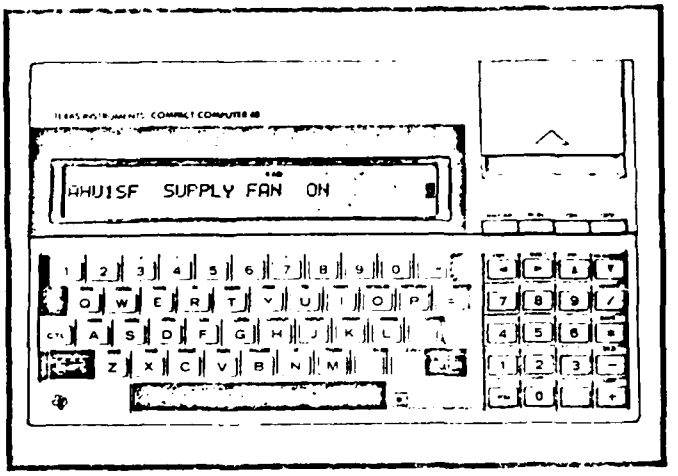
Energy Management Programs:
- Peak Demand Limiting
- Duty Cycling
- Start/Stop Time Optimization
- Time of Day Scheduling
- Economizer
- Enthalpy
- Resets

Custom HVAC Control Programs:
- Operator may program his own custom control sequences using MCC Powers proven Powers Process Control Language (PPCL)

Network Access:
- Connecting the portable terminal to any SCU allows the operator to access all other SCU's on the network and perform all of the above functions.

Features

- 31 character 5-by-8 dot matrix liquid crystal display that scrolls to the side to display a complete 80 character line.
- Adjustable display contrast.
- Standard typewriter keyboard layout plus quick entry numeric key pad.
- ASCII character set, including both upper and lower case alphabetic characters.
- Constant memory feature that retains information stored in memory when computer is turned off.
- Operates up to 200 hours on four AA alkaline batteries.
- Optional AC adapter to extend battery life
- Fold-out tilt stand for easy desk-top use.



System 600— Portable Operator's Terminal

- TMS70C20 CMOS 8-bit microprocessor, 34k ROM, 6k RAM.
- Audible tone during prompting.

Specifications

Dimensions	Width: 9.25 inches Depth: 5.75 inches Height: 1.00 inch Weight: 22 ounces
Power Supply	Four AA alkaline batteries or optional AC adapter
Internal Memory	6K RAM and 34K ROM
Display	31-character, (5 x 8 dot matrix). 18 special indicators, contrast control
Keys	69
Temperature	50°-150°F (10°-66°C)
Humidity	To 98% RH (noncondensing)

English Language Prompting

The use of a full English language interface ensures that the portable terminal is easily understood by all levels of operating personnel. An example of the English language prompting available with the system is shown in the following photos. Each photo shows the one line display of the operators terminal. The wording on the left of the display is how the system prompts the operator. The letters on the right hand of the display represent the response the operator has given to the system. The following set of photos walks the reader through the series of prompts an operator would use if he were adding a digital in point representing a differential pressure switch to the system.

Description

The basic stand-alone control unit consists of
1. SCU Enclosure
2. SCU Power Supply Assembly
3. Electronic Control Assembly
4. Wiring Termination Board

SCU Enclosure

Housing the SCU assemblies, the SCU enclosure consists of an 24" high x 24" wide x 9.4" deep (610mm x 610mm x 332mm) cabinet designed for wall surface mounting. Access to the cabinet is provided by a hinged front door equipped with a cam lock. An optional hinged front door comes with a removable panel to allow for the optional mounting of the handheld operator interface device. A connector is provided on the housing to connect the portable terminal MMI device to the SCU.

SCU Power Assembly

The SCU Power Assembly is housed in an approximately 17" high x 5.5" wide x 6" deep (431mm x 140mm x 152mm) perforated metal cover. The assembly contains a covered termination strip for connection of external power, an on-off toggle switch, and a power connector to connect the electronic control assembly and input/output boards to the unit. The SCU power supply assembly and the SCU enclosure are provided as a preassembled unit for convenience in installation. After the enclosure has been mounted, the power supply is set into place in the enclosure and secured with metal screw fasteners.

A standard duplex (AC) power receptacle is factory mounted within a 2" x 4" (51mm x 102mm) handy box and serves as the 120 VAC input power termination point. When input power is connected, this receptacle is also available to power test and service equipment.

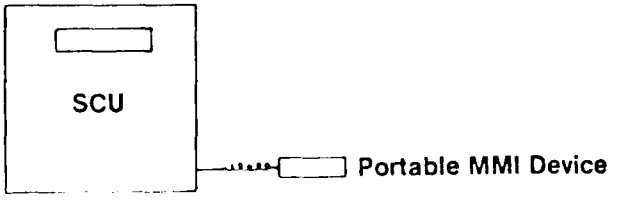


Figure 1.

SCU Electronics Control Assembly

The electronic control assembly consists of an electronic control board, a termination board, an optional communication board, and additional input/output boards as required. All of the boards are secured to the housing with quick-acting snaps.

Wiring Termination Board

The wiring termination board is a printed circuit board 10" high x 13.5" wide (254mm x 343mm). Inputs and outputs are wired to this termination board from the various sensors and control devices. All sensor wiring is done using screw connectors. Pneumatic sensing devices can be connected to a pneumatic-to-electronic transducer that mounts on the termination board.

SCU Network

Up to 32 SCU's can be connected using a multi-drop trunk to form a network. The user can address all SCU's on the network by simply plugging in an MMI device to any one SCU.

Man-Machine Interface

Each SCU contains one EIA RS232C port to allow use of various man-machine interface (MMI) devices, such as CRT's and printers. Each SCU also contains a separate port to allow the use of a portable MMI device. Any of the MMI devices-handheld, CRT or printer-can be connected to any SCU in the network.

With any of these MMI devices, the user can perform the following functions:
- Display all point status report
- Display alarm report
- Add, change or delete points
- Change setpoints
- Add, change, or delete custom control sequences
- Command points to a specific state

All of this can be done without any vendor assistance.

Figure 1 depicts a system with a portable MMI device connected to a single SCU.

In Figure 2, multiple SCUs are shown connected in a network. Here the system user communicates using a CRT and printer for hard copy output of reports. A portable MMI device can be connected to any SCU at any time to allow multiple users to access the network.

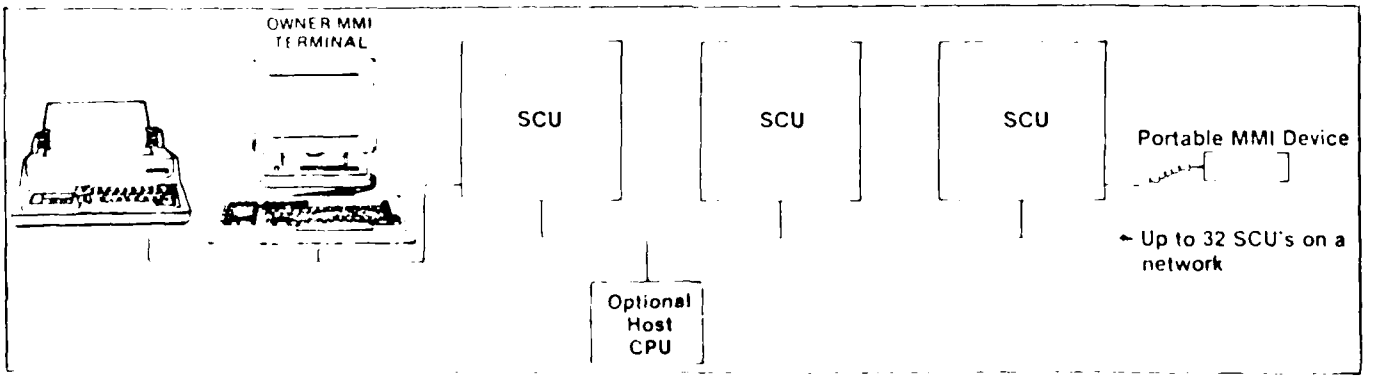
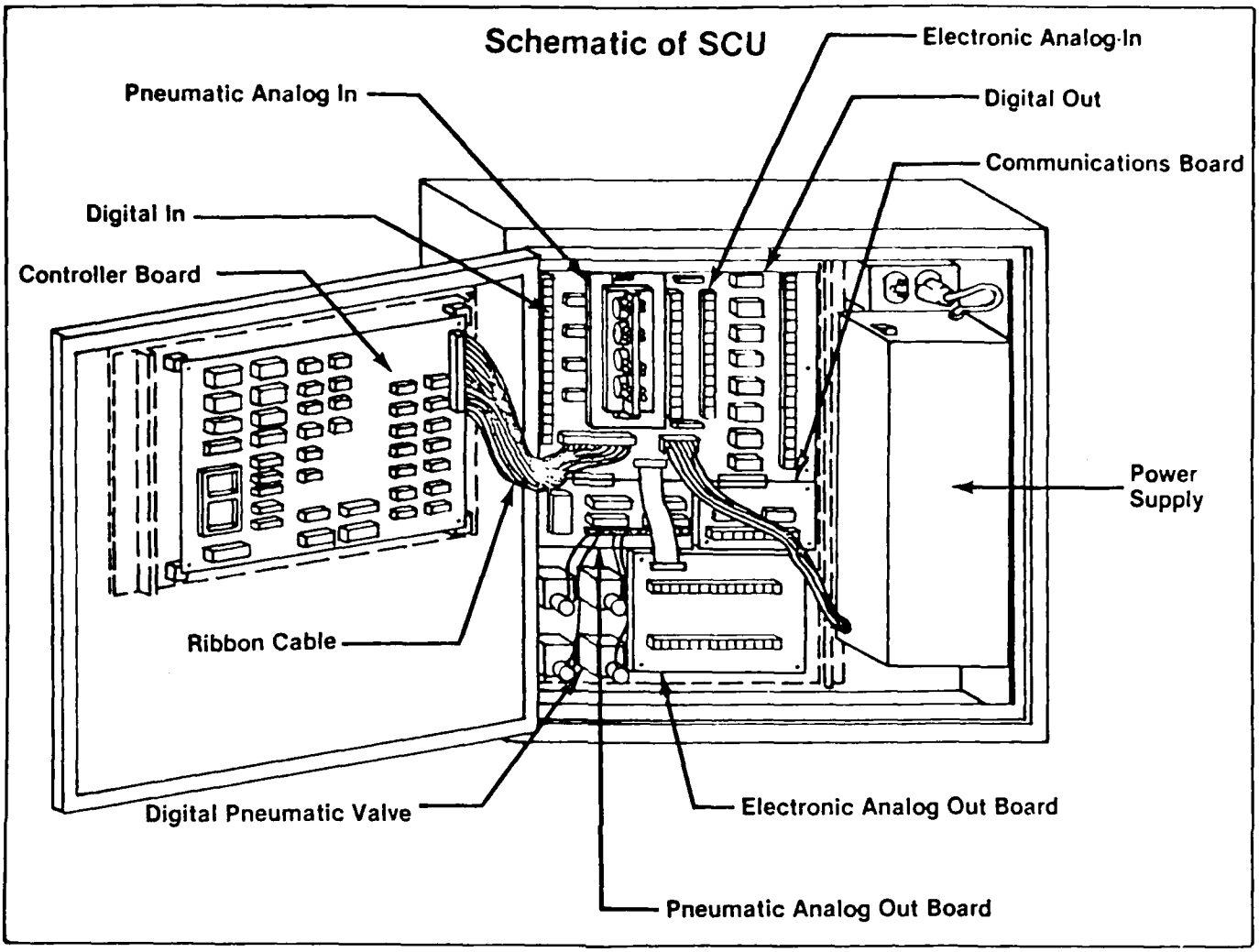


Figure 2.



Specifications

Power Requirements . . . . . 102 to 132 Vac, 59 to 61 Hz, 0.6 to 1.0 Power Factor, 300 watts maximum

Physical Characteristics . . . . . Size: Approximately 24"H x 24"W x 9.4"D (610mm x 610mm x 332mm)

Weight (Assembled) . . . . . Approximately 40 lbs. (18.1 kg.)

Operating Environment . . . . . (+32°F to 122°F) (0°C to 50°C)

Non-Operating Environment . . . . . (-40°F to +140°) (-40°C to +60°C)

Mounting Surface . . . . . Building wall or structural member. (Should not be mounted on HVAC components or other vibrating surfaces.)

Input/Output

Digital Input (DI) . . . . . 10 DI sensing dry contact
Standard . . . . . closure or pulse accumulator

Analog Input (AI) . . . . . 16 AI-E sensing 4-20mA,
Standard . . . . . 0-10V or a thermistor
Option . . . . . 8 AI-E can be substituted with optional 8 or 4 channel pneumatic input (AI-P)

Digital Output (DO) . . . . . 8 DO, can control up to size
Standard . . . . . 4 motor starter

Analog Output (AO) . . . . . 8 AO-P, where pneumatic
Option #1 . . . . . signal is 1-18 psig

OR

Option #2 . . . . . 8 AO-E, where output signal is 4-20mA, 0-16V, or 0-135 ohm

OR

Option #3 . . . . . 4 AO-P, and 8 AO-E

Architecture/Processor

Architecture . . . . . Multiprocessor computer system featuring 32/16 bit and 8 bit processors, distributed database, and distributed intelligence on the network

Program Memory
Standard . . . . . 48Kb RAM, 192Kb ROM
Optional . . . . . 64Kb RAM, 192Kb ROM

Processors . . . . . Motorola 68000 Multiple ZILOG 8603's

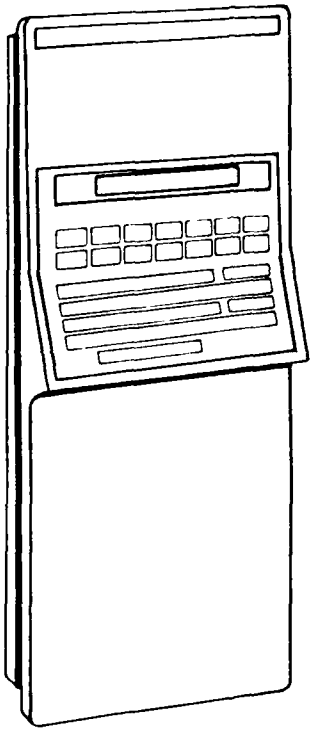
MARGAUX CONTROLS

MARGALIX

BUILDING AUTOMATION PRODUCTS

MX4000
PROGRAMMABLE CONTROLLER

- Refrigeration system control
- HVAC economizer / enthalpy control
- VAV control
- Boiler management
- Chiller optimization
- Photo-sensitive lighting control
- Maintenance logging
- Status monitoring
- Alarm generation / logging
- Data gathering and report generation
- Up to 48 outputs
- 24 analog inputs
- 24 digital inputs
- On-site data logging



- Time and date control scheduling
- Direct digital control
- PID control
- Optimum start / stop
- Sequenced start-up
- Load cycling
- Power consumption monitoring
- Demand limiting
- Night setback
- On and off overrides of outputs
- Local and remote alarm generation
- Graphing
- Local keyboard display
- Local RS232 port
- IBM workstation

- **Reduced Energy Costs**
- **English-Language Format**
- **Inexpensive and Easy to Install**
- **Extensive Management Report Capabilities**
- **Maintenance Reporting**
- **Self-contained**

Solutions for Building Automation.

48 DIGITAL OUTPUTS

- Outputs can be maintained or pulsed.
- Number of outputs can be sized to application.
- Relay logs generated for each output.
  - Accumulated on time.
  - Interval on time.
  - Interval off time.
  - Event counter.
  - General-purpose event timer.

24 ANALOG INPUTS

- Can display readings in eight different units.
- Supports all Margaux temperature, light-level, and dewpoint sensors.
- 0 - 5 VDC and 0 - 20 mA sensors.

24 DIGITAL INPUTS

- Digital inputs are scanned once per second.
- Digital input 17 scanned 75 times per second
- Digital logs generated for each input.
  - Accumulated on time.
  - Interval on timer.
  - Interval off timer.
  - Event counter.
  - General-purpose timer.

PROGRAMMING LANGUAGE

- Allows for flexible applications.
- English-language format.
- Easily maintained.
- Programming can be made application-specific.
- Help prompts throughout system.
- Yes / no question-and-answer format for easy access of information.
- Password protection.

REMOTE WORKSTATION

- IBM and Apple workstation.
- Auto-call feature.
- Alarm receiving.
- Remote programming.
- Remote monitoring.
- Remote override control.
- Graphing.
- Windowed software.
- Color display.
- 300 / 1200 Baud communication.

LOGGING AND MONITORING

- 32 user-defined logs.
- Three types of logs: auto, manual, and free-form.
- Power consumption monitoring.

POWER MONITORING

- Three demand variables: instantaneous demand, five- , and fifteen-minute sliding window demand.
- Daily and hourly logs of demand and consumption.
- Programming language to allow for demand control.

TIME AND DAY SCHEDULES

- 16 time-of-day schedules with 32 on / off events per schedule.
- 32-date schedules for alternate or special days.
- Date ranges can be specified.

DIMENSIONS

- 16 inches wide, 34 inches high, 5 inches deep.

ELECTRICAL

- 120 VAC 50 / 60 Hz 0.3 amp.
- Rechargeable Nicad battery back-up for 100 hours of memory and clock retention

OPTIONS

•64K logging memory. •Modem. •Up to 48 digital outputs in increments of 12.
•Analog / digital inputs. •Front panel keyboard.

MARGAUX

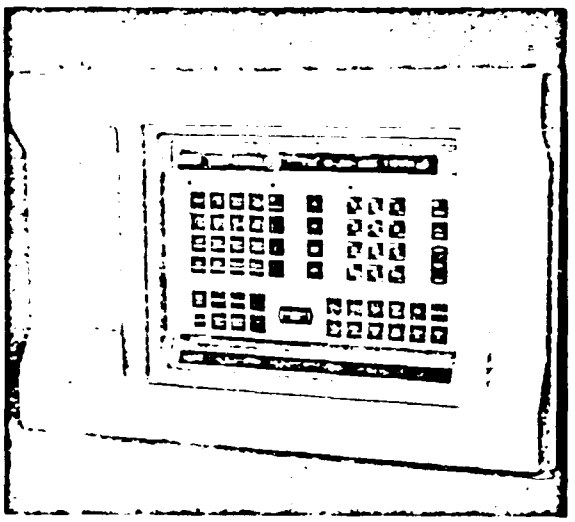
Solutions for building automation

MARGAUX CONTROLS INC
2890 North First Street
San Jose CA 95134
(408) 942 0909

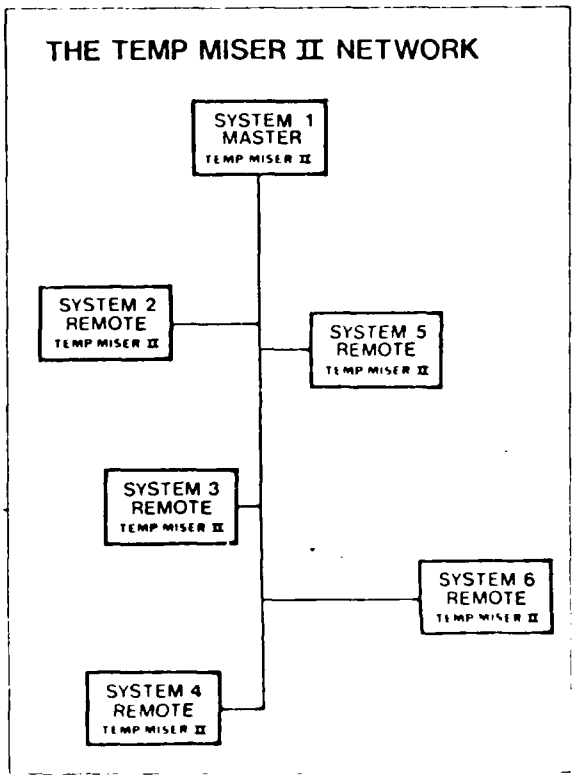
MICROCONTROL SYSTEMS, INC.

MCS TEMP-MISER II™

- **Expanded Capability for Commercial, Retail and Industrial Applications**
- **Multi-drop for Distributed Processing**
- **Priority Demand Control and Scheduling**
- **Advanced Duty Cycling**
- **Boiler Reset and Chiller Control**
- **DDC for Valve and Damper Control**
- **IBM-PC Interface for Remote Communications, Data Logging and History Tracking**



Expanded capability of the MicroControl Systems, Inc. product line has been realized with the introduction of the TEMP MISER II, a second generation energy management system of proven reliability and integrity. Direct digital control and networking are two major strategies that are characteristic of the TEMP MISER II. In addition, increased capabilities have been added to metering, input, output, sensor, alarm and data acquisition/reporting functions. Consistent with our product line philosophy, increased capabilities *does not* mean increased complexity of operation. The TEMP MISER II provides the above features while maintaining the same easy-to-use strategy that has always been a trademark of the entire MCS product line.



Networking

In addition to having complete stand alone capabilities, up to six TEMP MISER II units can now be linked together to allow for increased load capabilities, shared resources and the development of a complete distributed control network. The system is centered around a designated master MISER II which performs monitoring and program operation to each slave unit linked to the network. All programming and monitoring interface takes place at the master unit. Linked together a TEMP MISER II network would provide control of up to 96 loads as well as 36 sensor monitoring points. In the event that network communications are lost, each TEMP MISER II will continue to operate independent of the network system.

Direct Digital Control

The MCS direct digital control strategy utilizes a combination of hardware components and software algorithms (mathematical equations) to maintain the controlled variable (temperature, pressure, relative humidity, flowrate, etc.) or the industrial manufacturing process. The procedure used to implement DDC in the TEMP MISER II is similar to other load types. Variables are defined by the same easy to use menu driven sequence. All programming can be done at the master Miser-II.

Inputs

In addition to accommodating 16 analog signals for temperature and other variable input control, the TEMP-MISER II can accept up to 16 additional digital inputs for timed override, digital alarm, load verify and basic control functions. In a TEMP-MISER II network system one Miser is assigned to monitor and provide the outdoor temperature to the entire network. In addition all sensors have an enterable scale within the range of — 999 to 9999, which allows the user a great deal of flexibility in sensor selection.

Total system capabilities include 96 digital and 96 analog inputs.

Outputs

Each TEMP-MISER II has 16 digital outputs. Standard digital outputs utilize normal mechanical output relays while DDC outputs use solid state relays.

Direct digital outputs consist of one of two types. In a time-based mode, one output maintains an ON/OFF ratio with a programmable time window. In a RAISE/LOWER mode, two outputs operate as a set. Both of these types of outputs allow a feedback sensor from the primary control loop. A reset control loop can also be implemented to adjust the set point of the primary control based on an external sensor input.

The total TEMP-MISER II network system has 96 digital outputs available.

Metering

Two meter inputs are available on each Miser-II with a total system capability of 12 meter inputs. Meter one of one Miser-II would be assigned as the demand meter. Demand is therefore controlled for the entire system by the assigned demand meter based on a user programmed priority of sheddable loads.

Up to four (4) billing periods can be defined to handle time of day billing and collect data for usage and peaks respectively for each period.

History

The flexibility and capability of data acquisition and reporting functions for the TEMP-MISER II has been greatly expanded. History of meter data, sensor data, load run times, load status and digital input data can be gathered and viewed locally or printed in report form with the optional communications package for IBM-PC compatible devices.

IBM-PC Communications

Whether you have one TEMP-MISER II or a complete network of six, you only need one modem to access any single unit. When accessing a TEMP-MISER II within a network system all communication goes through the master Miser-II. Security for access to a stand alone unit or a TEMP-MISER II system is accomplished by the use of an eight (8) digit password.

Product Specifications

Operational

- 32-Character Alpha/Numeric Display
- 16 Digital outputs per unit, 96 per system
- 16 Analog inputs per unit, 96 per system
- 16 Digital inputs per unit, 96 per system
- 2 Hour Battery backup
- 30-Date holiday scheduler, 365 day time clock

Electrical

Input Voltage: 120 VAC/60HZ or 240 VAC/50 HZ

Power Consumption: 60 Watts @ 120 VAC

Circuit Protection: 2 A Fused Circuit on Input Power

Output Relays:

- Mechanical: SPDT Dry Contact Isolation Relays rated @ 25 VAC/2 A
- Solid State: 24 VAC solid state relay, capacity 1.5 A @ 24 VAC

Mechanical

Dimensions: 16" x 22" x 4"
(40.6 CM x 55.8 CM x 10.2 CM)

Weight: Operating - 25 pounts (11.3 KG)
Shipping -- 28 pounds (12.7 KG)

Enclosure: High impact, durable phenolic cover, metal base wall mount

Ambient Conditions: 0-50° C
0-90% RH non condensing

System Network

- Maximum System Configuration
  Six (6) Temp Miser II's
- Communication Rate: 2400 BAUD
- Communication Interface: RS 485
- Maximum Distance to Farthest Remote
  2,000 ft.
- Wiring: 3 wire 18 gauge

MicroControl Systems inc.

the energy systems company

CORPORATE HEADQUARTERS
6579 North Sidney Place
Milwaukee, Wisconsin 53209
414/351-0281
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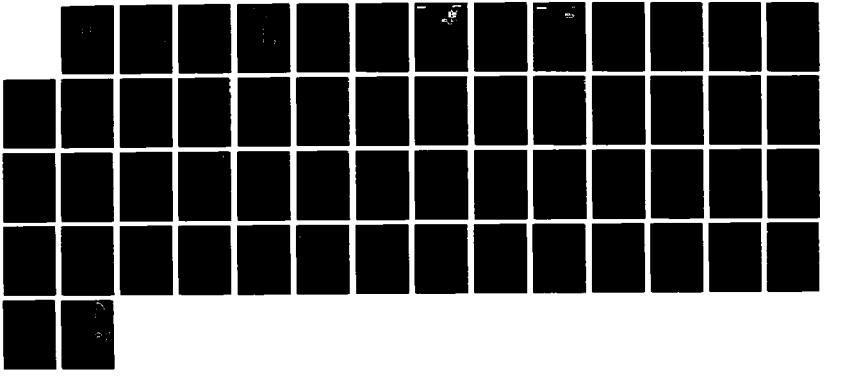
87 Gurnards Ave.
Milton Keynes MK6 2 BW
ENGLAND
Phone: 0908-667067
TELEX 826556 Sursec

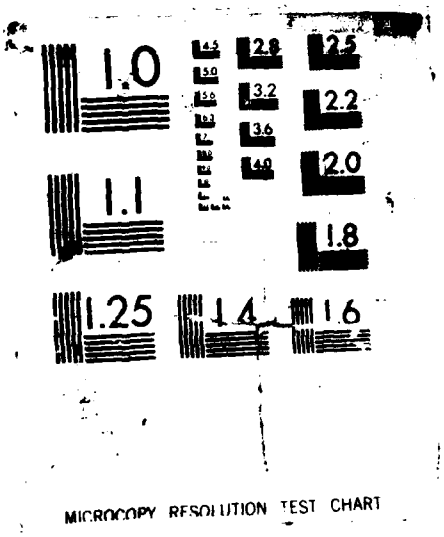
REPRESENTED BY

MICROMIZER, INC.

AD-A184 003 SURVEY STATE OF THE ART: ELECTRICAL LOAD MANAGEMENT TECHNIQUES AND EQUIPMENT(U) ENVIRO-MANAGEMENT AND RESEARCH INC SPRINGFIELD VA N KHOSLA 31 OCT 86 3/3

UNCLASSIFIED DAAK70-86-C-0035 F/G 10/2 NL



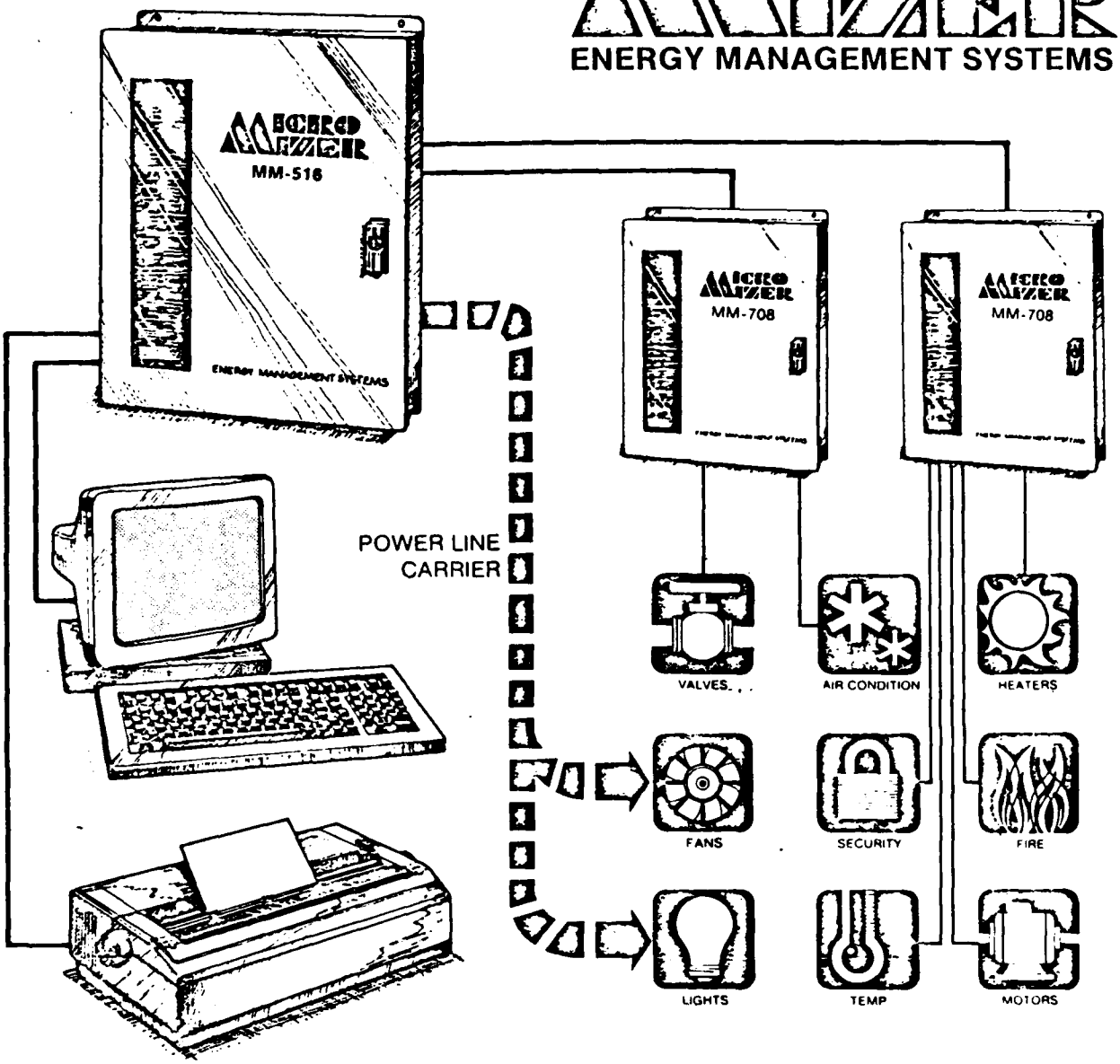


MICROCOPY RESOLUTION TEST CHART

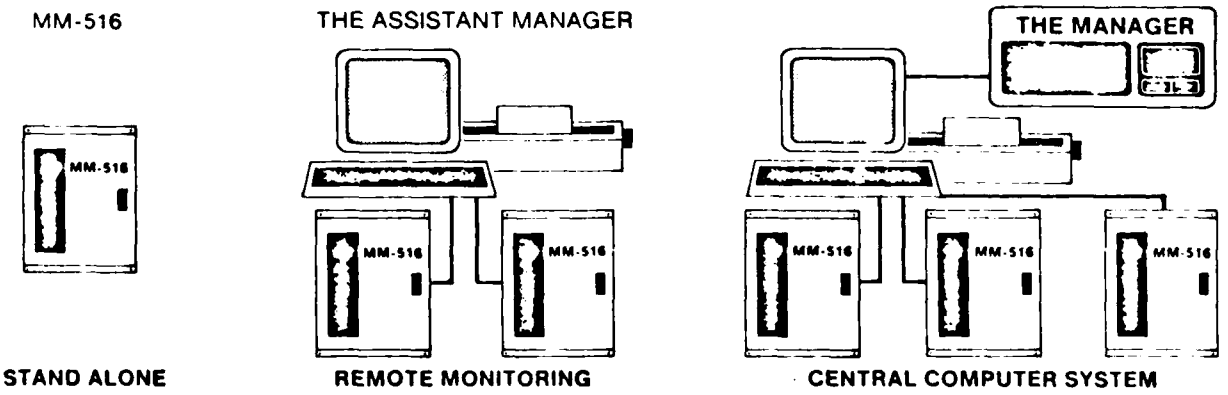
MM-516

MICRO MIZER

ENERGY MANAGEMENT SYSTEMS



MICRO-MIZER BUILDING AUTOMATION SYSTEMS



MM-516 ENERGY MANAGEMENT SYSTEM

CUSTOM DESIGN

The MM-516 Energy Management System is configured for your specific design to give you maximum savings while maintaining total flexibility.

DYNAMIC SCHEDULING

You can schedule the use of a room, zone or building up to a year in advance. Just enter the day, time and area . . . the rest is automatic. Your facility will save energy dollars by remaining in set-back mode for all but the actual use times.

PERMANENT MEMORY

The MM-516 Energy Management System will never lose your program because it's PERMANENTLY ETCHED on Read Only Memory (ROM) chips. And it has up to 87K RAM/ROM memory.

PERPETUAL CALENDAR CLOCK

The real time clock in the MM-516 knows the year, month, day and time down to 1/10 of a second. This gives accurate control of your facility. The automatic adjustment for leap year and daylight saving time makes this a truly automatic system. It includes 72 hour battery back-up.

DIRECT WIRE

Any combination of 1,024 input/output points can be direct wired to control boilers, chillers, lighting circuits and motor loads while detecting temperature, humidity and true equipment status.

DDC-DIRECT DIGITAL CONTROL

Dedicated processing unit(s) execute control point adjustments. These units provide easy-to-modify control sequences and increased system reliability.

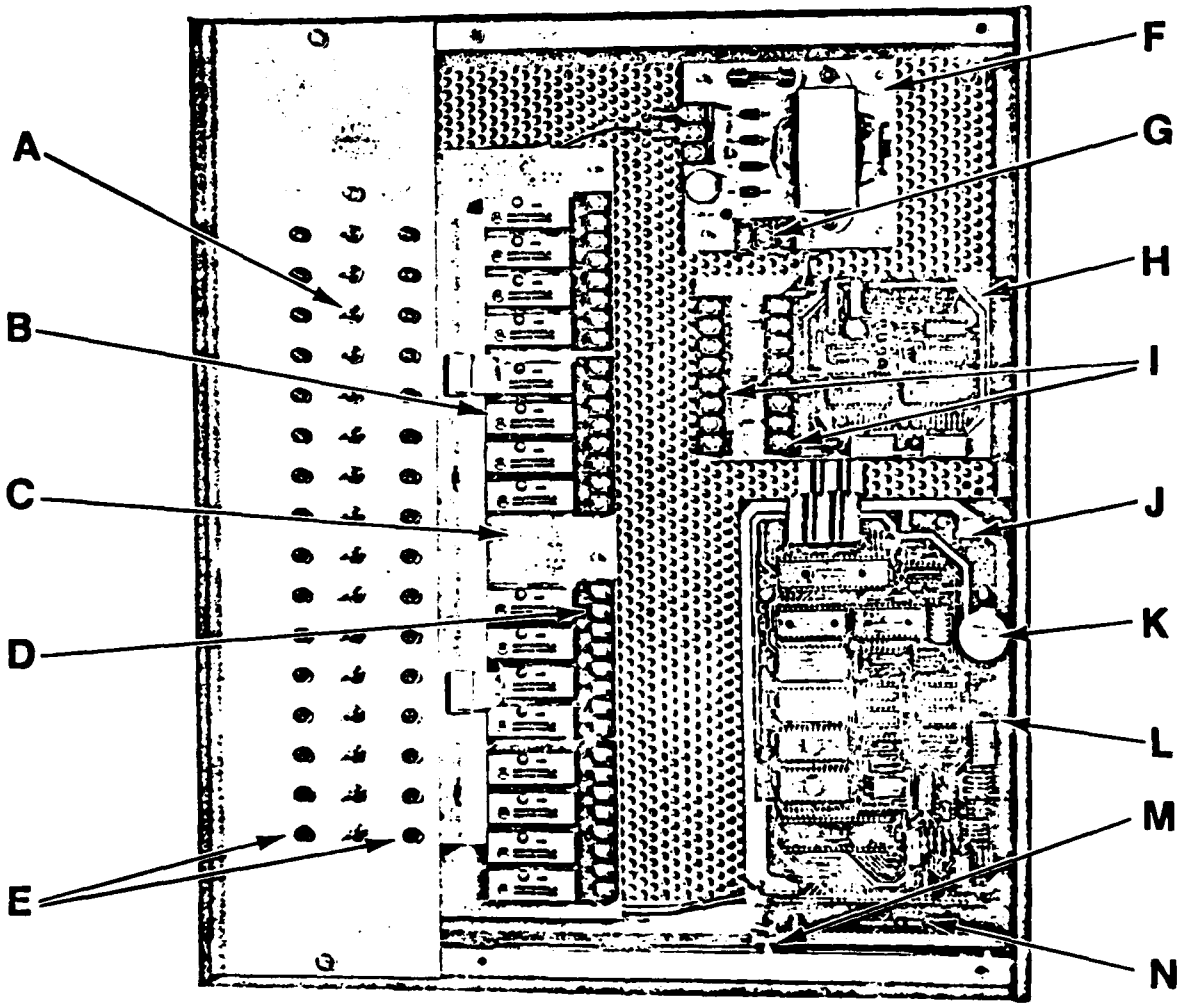
OPTIONS:

CENTRAL STATION
REMOTE STATIONS
POWER LINE CARRIER
PRINTERS
MODEMS

SPECIFICATIONS:

SIZE: 18"H x 15"W x 5"D
INPUT VOLTAGE: 120v AC 60 Hz; 60 Watts
OPERATING TEMPERATURE: 0° to 140°F
MEMORY: Up to 87K RAM/ROM
INTERFACE: SERIAL RS-232D
INPUTS: Maximum 32 RPU's (Slaves)
Maximum 32 DGP's
Maximum 512 Analog
Maximum 512 Binary
OUTPUTS: Maximum 256 Analog (DDC)
Maximum 512 Binary

MM 0005-08 84



A. Manual override switches
B. Solid state relays (I/O relays)
C. Solid state relay board (I/O board)
D. Load terminal strips (#6 screw)
E. Load status indicators and override LED's
F. D.C. power supply
G. 120 VAC power in terminals
H. 8 channel analog/digital conversion board
I. Sensor terminal strip (#6 screw)
J. RS-232 serial port
K. 72 Hour battery back-up
L. Central processing unit board
M. Multiplex cable connector
N. Memory expansion rack

0007-12-84

MM-101 BOARD Used in conjunction with Industry standard solid-state opti-couplers. Output may be normally open or normally closed, 90-289 Vac, 3 Amp or 60-200 Vdc. 3 Amp. Input may be 90-280 Vac or 4-32 Vdc. Any combination of Inputs or Outputs. Unit comes with 16 channels.

MM-301 BOARD Eight point analog to digital converter. Resolution is 8-bit. Variable reference voltages allow use of temperature, humidity, and light intensity probes.

MULTIPLEX CABLE CONNECTOR ART/RC Master for serial transmission, single wire, data I/O of 128 "slaves" using 3 #18 shielded cable.

BATTERY BACK-UP Nickel cadmium battery, with 100 mh of power. Each 16K of memory has own battery which backs up memory and clock.

CPU BOARD Powerful central processor is programmed in Basic for easy, user-friendly programming. Self-diagnostic software allows for error free operation.

PERPETUAL CALENDAR CLOCK The real time clock in the MM-516 knows the year, month, day and time down to 1/10 of a second. This gives accurate control of your facility. The automatic adjustment for leap year and daylight saving time makes this a truly automatic system. It includes 72 hour battery back-up.

SPECIFICATIONS:

SIZE:	18"H x 15"W x 5"D
INPUT VOLTAGE:	120v AC 60 Hz; 60 watts
OPERATING TEMPERATURE:	-17 degrees to +70 degrees C.
MEMORY:	Up to 87K RAM/ROM
INTERFACE:	Serial RS-232D
DIGITAL INPUTS/OUTPUTS:	16 standard expandable to 64 points
ANALOG INPUTS:	8 standard expandable to 32 points

(313) 435-2210

OMRON ELECTRONICS, INC.

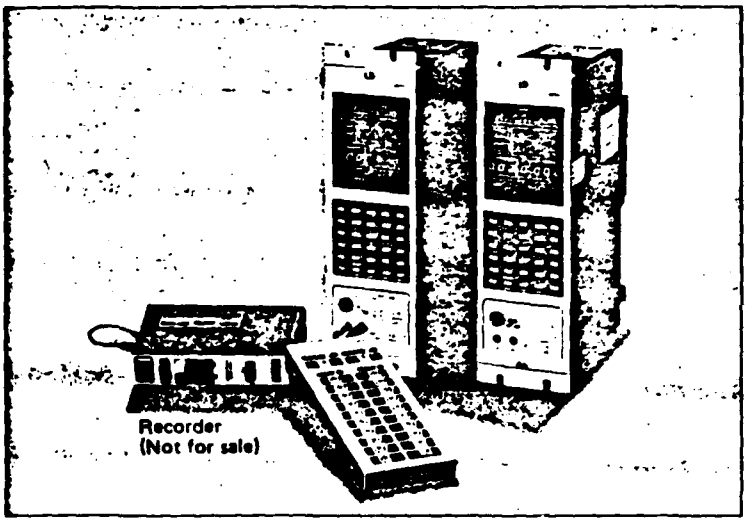
OMRON

PROGRAMMABLE CONTROLLER

Cat. No. P11-E3-2

Model SYSMAC-P0R

Rugged, Compact, Slim-line High-performance Ladder Diagram Type



FEATURES

- Rugged construction, yet allows flexible mounting
- PROM writer function incorporated in Type SCY-P0R20E
- Continuity (trace) checking is possible
- Programs may be dumped onto any cassette tape
- Detectable connector for easy maintenance and inspection

AVAILABLE TYPES

Classification	Components	Type
RAM type	RAM type CPU, I/O unit, Connecting cable [20cm(7.874")], Battery, Mounting brackets (L-shaped/Flat type)	SCY-P0R10E
RAM & ROM type	RAM & ROM type CPU, I/O unit, Connecting cable [20cm(7.874")], Battery, EPROM, Mounting brackets (L-shaped/Flat type)	SCY-P0R20E

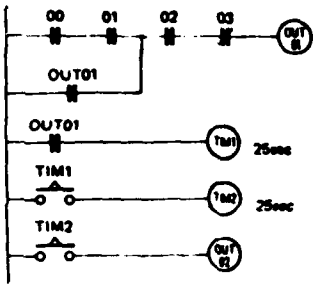
OMRON

SPECIFICATIONS

Supply voltage	110/120/220/240 VAC, 50/60Hz
Power consumption	55VA max.
Scan time	21msec max./256 words
Programming capacity	RAM: 256 words EPROM: 256 words x 4
Number of input/output points	Input: 20 points Output: 16 points Internal auxiliary relay: 59 points Latching relay: 47 points Timer: 10 points (0.1 to 25.5 sec.) Counter: 10 points (1 to 255 counts)
Input specification	No voltage contact input (Internal power supply: 20 VDC 10mA)
Output specifications	Output form Relay (SPST-NO) contact output (no-voltage) Max. applicable load: 30 VDC/250 VAC 2A, resistive load 30 VDC/250 VAC 0.8A, inductive load
Number of special auxiliary relays	5 points (Relay Nos. 59 ~ 63) • 59: Turns ON for 1 scan time when power is applied • 60: generates 0.1 sec clock. • 61: generates 1 sec clock. • 62: Turns ON when the battery is abnormal. • 63: Turns ON when the memory is abnormal
Number of special latching relays	1 point (Relay No. 47) When relay No. 47 is set, all outputs are inhibited and the output display goes out.
Memory protective function against power failure	Status data of respective latching relays and counters before the power failure are retained in the memory.
Diagnostic functions	Memory failure (Sum check) CPU failure (Watchdog timer) Battery failure (Battery not loaded, battery voltage drop) Program check • Coil duplication check • END instruction check • Circuit error check (syntax check)

PROGRAMMING EXAMPLES

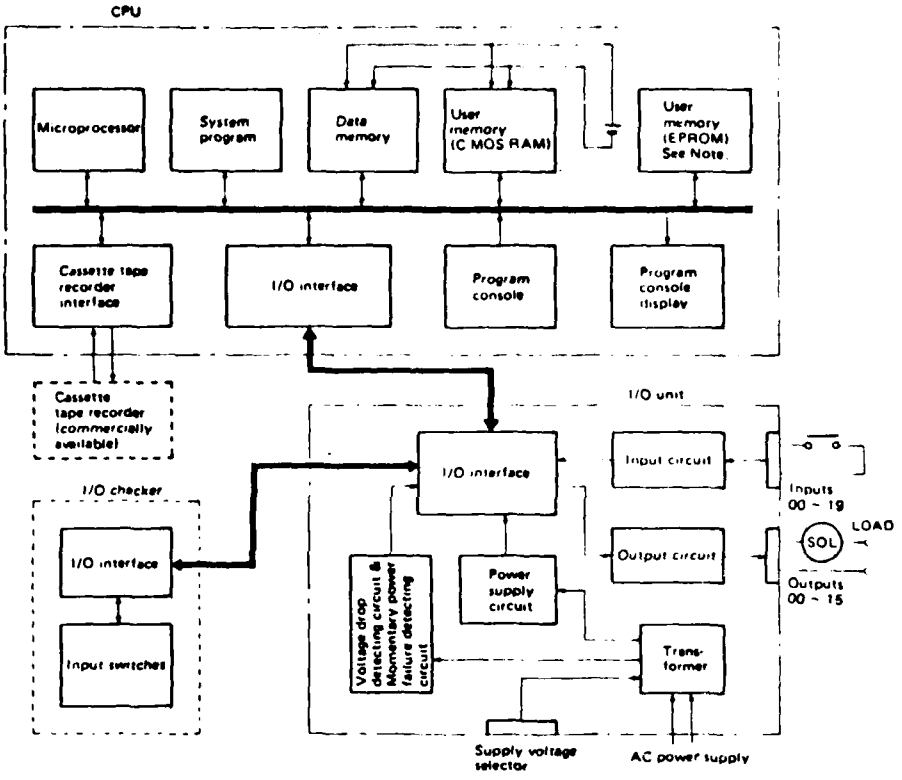
- **LADDER DIAGRAM PROGRAMMING**



- **CODING**

OP	Sub OP	Data
LD		00
AND		01
OR	OUT/1	01
AND		02
AND-NOT		03
OUT		01
LD	OUT/1	01
TIM	1	250
LD	TIM/4	1
TIM	2	250
LD	TIM/4	2
OUT		02
⋮	⋮	⋮
END		

SYSTEM CONFIGURATION

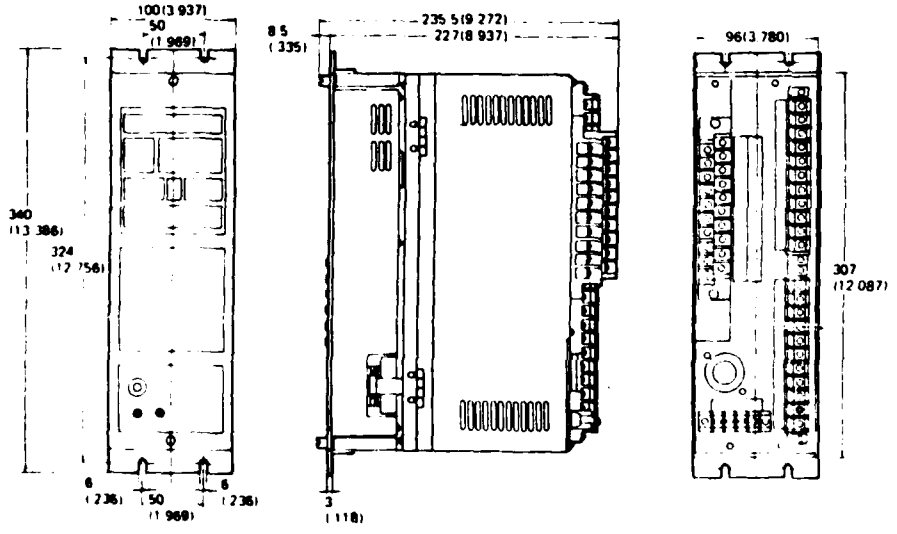


NOTE Type SCY P0R10E (RAM type) is not provided with a user memory (EPROM).

APPLICATIONS:

- Machine tools
- Printing presses
- Packing and packaging machines
- Industrial robots
- Food processing machines
- Conveyors
- Assembly lines

DIMENSIONS [Unit: mm(inch)]



NOTE: DIMENSIONS SHOWN IN THIS CATALOG ARE IN UNITS OF MILLIMETERS, AND THOSE IN PARENTHESES ARE IN INCHES.

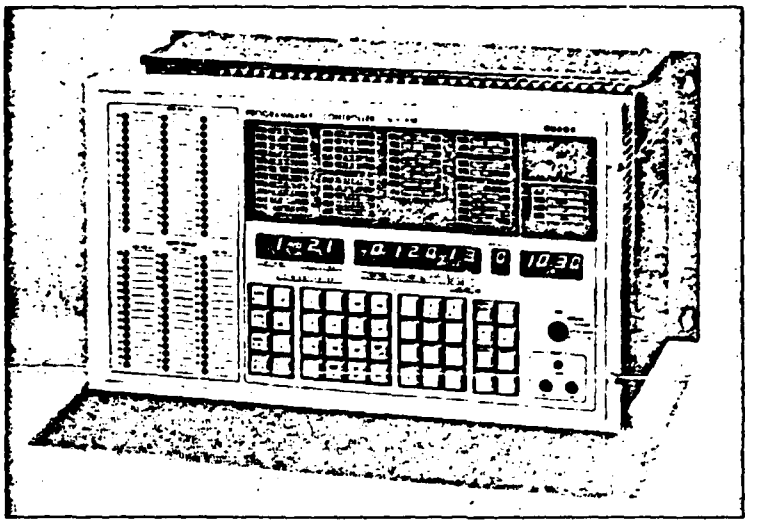
OMRON

PROGRAMMABLE CONTROLLER

Cat. No. P12-E3-2

Model SYSMAC-P5R

Operator-oriented Programmable Controllor, with a Sequencer in a Single Enclosure



■ FEATURES

- Integrated program console for flexible programming (both ladder diagram and sequence control systems)
- Continuity (trace) checking possible
- RAM-type CPU and RAM- & ROM-type CPU available
- Built-in 24-hour clock for time control
- PROM writer function (RAM- & ROM-types CPU only)
- Programs may be dumped onto any cassette tape

■ AVAILABLE TYPES

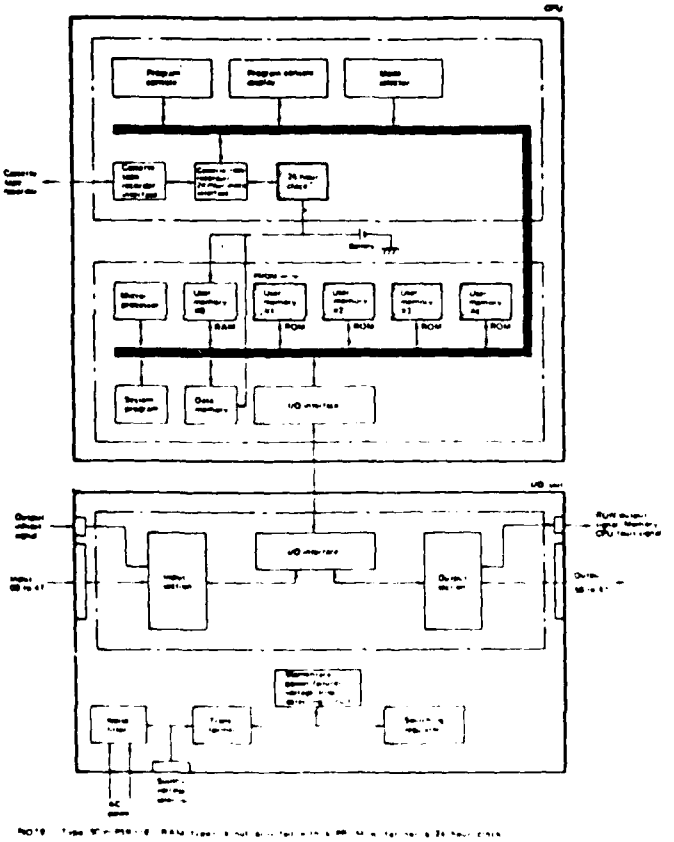
Classification	Specification	Type
RAM & ROM type	RAM (2 KW) & ROM type CPU, 48/48 I/O Cassette I/F, PROM write: with 24-hour clock	SCY-P5R10E
	RAM (1 KW) & ROM type CPU, 32/24 I/O Cassette I/F, PROM writer with 24-hour clock	SCY-P5R30E
RAM type	RAM (2 KW) type CPU 48/48 I/O, cassette I/F	SCY-P5R11E
	RAM (1 KW) type CPU 32/24 I/O, cassette I/F	SCY-P5R31E

OMRON

■ SPECIFICATIONS

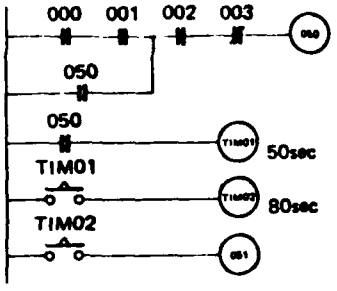
Supply voltage	110/120/220/240 VAC, 50/60Hz
Power consumption	Approx. 160VA
Main control element	8-bit microprocessor
Program memory element	CMOS RAM or EPROM
Programming system	Ladder diagram and/or timing chart system
Program capacity	Ladder diagram type: RAM: 2k words EPROM: 2k words x 4
No. of sequencers (Timing chart system)	3 (99 steps/sequencer)
No. of input/ output points	Input: 48 points max. Output: 48 points max.
Input specification	No-voltage contact input Internal power supply: 20 VDC 10mA
Output specification	Relay contact output *(SPST-NO) 220 VAC/24 VDC 2A (*OMRON Model G3F Solid-state Relay can also be used.)
Scan time	Ladder diagram type: 38msec/1k words Step advance type: 500μsec/step controller + 9msec

■ SYSTEM CONFIGURATION



PROGRAMMING EXAMPLES

- LADDER DIAGRAM PROGRAMMING



OP	Data
LD	000
AND	001
OR	050
AND	002
AND-NOT	003
OUT	050
LD	050
TIM	01
	500
LD-TIM	01
TIM	02
	800
LD-TIM	02
OUT	051
⋮	⋮
END	

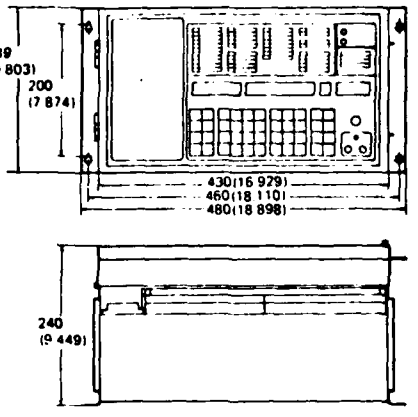
- TIMING CHART PROGRAMMING

TIMING CHART

Input/Output (Relay No.) \ Process		0	1	2	3	4
Input	Start Button: PBS (000)					
	LS1 (001)					
	LS2 (002)					
Timer				7sec.		
Output	Forward Motor: MF (050)					
	Reverse Motor: MR (051)					

ADDRESS	STEP NO.	OP	DATA		STEP CON out							
			DATA1	DATA2	050	051	052	053	054	055	056	
0020		STEP CON		0								
0021 ~ 0027	01	AND	000	001								
0028 ~ 0034	02	OR	002	002	ON							
0035 ~ 0041	03	TIM	070	000								
0042 ~ 0048	04	OR	003	001		ON						
0049 ~ 0055	05	STEP END										
0056		MANU END										

DIMENSIONS (Unit: mm(inch))

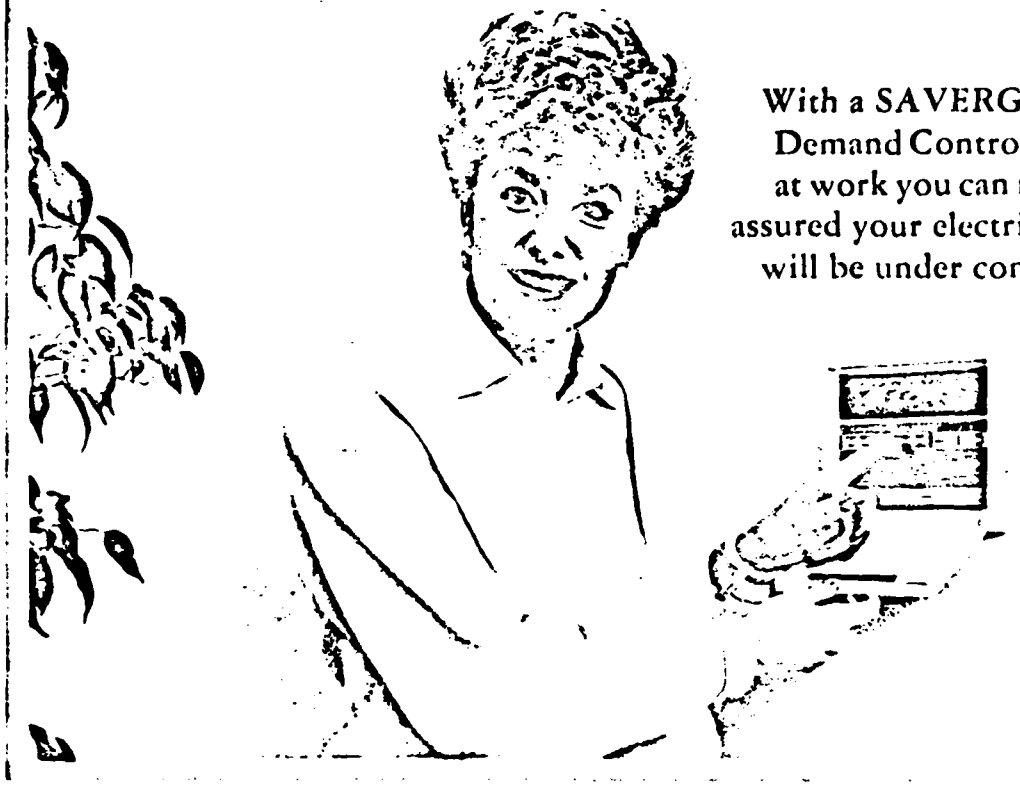


APPLICATIONS:
- Machine tools
- Packing and packaging machines
- Food processing machines
- Printing presses
- Conveyors
- Assembly lines

NOTE: DIMENSIONS SHOWN IN THIS CATALOG ARE IN UNITS OF MILLIMETERS, AND THOSE IN PARENTHESES ARE IN INCHES.

SAVERGY, ENERGY SYSTEMS, INC.

SAVERGY®

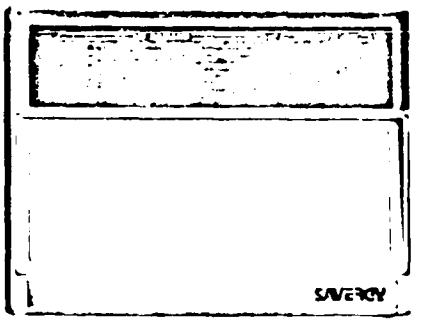


With a SAVERGY® Demand Controller at work you can rest assured your electric bills will be under control.

FEATURES OF THE SC212

The Savergy® SC212 (Demand Controller) is the most technologically advanced demand controller on the market today. Savergy's highly sophisticated and reliable design offers today's homeowners features not found in other demand controllers. The system's advanced control software makes the SC212 a truly intelligent demand controller to provide the user with increased comfort and convenience as well as maximum energy savings. Some of the advanced features are:

1. Control Points - Eight separate control points for maximum energy utilization. Up to 16 controlled loads with Double-Pole Relays.
2. Digital Read-out - Displays instantaneous, average, or peak demand for precise monitoring of power usage.
3. "Circuits ON" LED indicators display ON/OFF load status.
4. Non volatile EEPROM microprocessor memory - insures retention of all control functions following any power loss. No batteries required.
5. Over-Limit Alarm - sounds if over demand set-point condition is imminent.
6. On/Off Times - Programmable 0 to 15 minute MINIMUM ON and OFF times on all eight control points for efficiency and to protect heat-pump air conditioning loads or other motor loads.
7. Priority-Flex programming gives choice of virtually unlimited load control strategies (rotate, fixed, fixed-rotate combination, dual-rotate to maximize adaptibility to load requirements and environment.



SAVERGY®

Model SC-212

8. Demand Averaging Period of 15, 30, and 60 minutes.

9. Demand Range - Programmable to 40 or 80 KW for use on 200 amp or 400 amp electrical services.

10. Three-channel utility interface for Time-of-Demand rates and connection to utility direct control program receiver, timer, or other activation device.

11. Custom distributed control system strategies available.
    - Set back demand for ON-peak.
    - Set-up multiple of demand for OFF-peak.
    - Control disable for OFF-peak.
    - Multiple set points for ON/OFF peak or summer/winter setting.

The Savergy® SC212 is designed and manufactured to the highest quality standards in the industry today by Savergy Energy Systems, Inc., a name synonymous with quality in demand energy controls. From the people who brought you the industry standard SC112. With Savergy®, you can be assured your electric bills will be under control.

SC212 SYSTEM

RELAY UNIT

Function: Performs power (demand) signal conditioning and load switching. Supplies power to Control/Display Unit.

Components: Power (demand) signal conditioning circuitry (+5% accuracy), load switching circuitry, enclosed mechanical power relays and Control/Display Unit power supply.

Capacity: Controls up to 240 amps at 25°C for 200 amp household service. A maximum of sixteen circuits using either 115 or 230 volts may be connected thorugh standard combinations of single or double pole 25 or 30 amp mechanical relays.

Options: For motor loads optional low voltage mechanical pilot relays may be specified. Expanded control of services up to 400 amps may be accommodated upon special order. An additional option is available to accommodate three phase service.

Power Supply: 115 Volts A.C., 0.2 amp

Outside Dimensions Specifications: 12" x 8" x 4" NEMA 3R Surface Mount, or 15" x 12" x 4" NEMA 1 Flush Mount.

CONTROL DISPLAY UNIT

Display and Alarm: User set kilowatt demand limit and actual kilowatt demand are displayed utilizing high efficiency LEDs. Actual demand may be displayed as instantaneous, 15 minute average, or peak-demand-since-reset for maximum flexibility in determining optimum energy use patterns. The on/off condition of up to eight separate circuits is displayed by eight "Circuits On" status lights for added monitoring convenience. A solid state audio alarm and "Reduce Demand" indication will activate when demand of uncontrolled loads exceeds user-set demand limit. The display indication features variable intensity for matching existing lighting conditions. The audio alarm volume is adjustable to satisfy user requirements.

Components: Includes Duralogic™ microprocessor memory, system definition circuitry, control status display circuitry and solid state audio alarm transducer.

Outside Dimensions: 7-7/8" W x 5-5/8" H

Wall Insert Dimensions: 7-1/8" W x 5-1/8" H

Wall to Front Surface: 1"

Recessed Depth: 2"

Manufactured by:
SAVERGY, ENERGY SYSTEMS, INC.
1404 Webster Ave.
Fort Collins, CO 80524

LOAD CONTROL STRATEGIES

The Savergy® SC212 is the most versatile residential demand controller available. With Savergy's new advanced "Priority-Flex" programming algorithm, the user can assign up to 8 levels of priority, to up to 8 control points. This offers the user a choice of unlimited load control strategies allowing maximum adaptability to household load requirements. These strategies, described below, include the Fixed Priority strategy, the Rotate strategy, the Fixed-Rotate strategy, and Dual-Rotate strategy, in virtually unlimited combinations. When the user-set demand limit is exceeded, actual demand is reduced by turning off controlled loads according to the strategy selected.

For added flexibility and motor load protection, all control circuits feature programmable minimum on/off times, ranging from 1 minute to 15 minutes. Load control strategies and minimum on/off times may be selected through the front panel of the Control/Display Unit. The four primary load control strategies are:

- **Fixed Priority Strategy:** Up to eight household circuits are turned on and off in order of priority from 1 through 8 where loads switched by control circuit 1 have the highest priority.

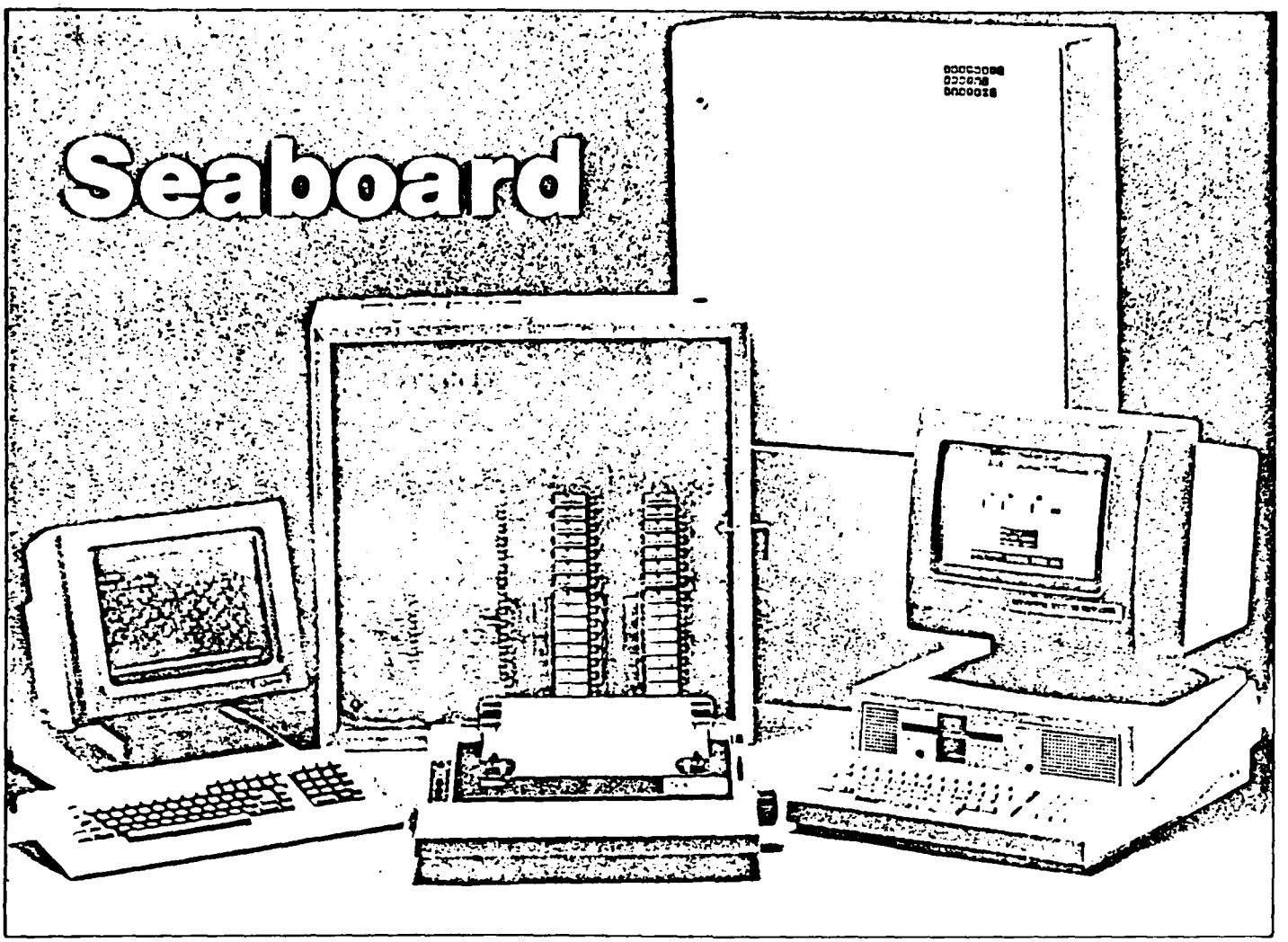
- **Rotate Strategy:** Under this strategy, all eight control circuits are assigned an equal but rotating priority, which turns off loads sequentially every 30 seconds as required to maintain demand below the limit. Unless all rotating loads must be turned off, the first load previously off is restored at the beginning of each 30 seconds interval.

- **Fixed/Rotate Strategy:** This strategy combines aspects of the Fixed Priority strategy and Rotate strategy such that up to 3 control circuits may receive first, second, and third priorities with the remaining control circuits assigned a lower rotating priority.

- **Dual Rotate:** This strategy allows for 2 or more groups of rotating loads. For example, 3 loads could rotate among themselves as priority and the remaining 5 loads could rotate among themselves as priority 2.

FORT COLLINS, CO (303) 221-4200

SEABOARD ENERGY SYSTEMS, INC.



The Seaboard™ System 90 is highly modular both in the number of points which can be monitored or controlled and in the specialized energy management/control subsystems that can be employed. It can operate as a stand-alone system or as part of a distributed network with up to 32 systems. A single System 90 can control or monitor 96 points, a System 90 network over 3000 points.

Proportional Integral Derivative (PID) logic and Direct Digital Control (DDC) are standard features of the system. As an option, the system can include dynamic color graphics, data logging, and disc upload/download capabilities. A real time clock and battery backup are standard. Multiple terminals can be included so that the Seaboard™ System 90 can be operated from more than one location. A modem can permit access to system data control from any telephone location with a portable terminal. A multilayered operator ID code restricts entry to those with the necessary "key." English language statements are used to command the system.

The modular Seaboard™ system software includes:

Chiller Management/Control - provides for complete automation and control of a chilled water plant with the option of automating the condenser water system. Multiple chillers and multiple loops can be controlled.

Damper Control -- performs mixed air control and reset for constant and variable air volume systems. Mixed air temperature control, reset, and/or enthalpy-based economizer operation is available. Duct averaging sensors are used to eliminate errors due to stratification effects.

Heat/Cool Reset -- is designed to control and adjust setpoint of chilled water, hot water, and/or steam coils to achieve specific discharge air temperatures in a zone or zones. This subsystem uses outside air or key zone conditions and is programmable by time of day.

Temperature-based Load Control—provides for peak demand load shedding, daily tables for different energy management strategies based on time of day and day of week, normal/setback temperature override, optimized start/stop, automatic adjustment for daylight savings, degree day calculations, and special commands for lighting control are standard.

Boiler Management/Control—is designed to manage and control multiple package jackshaft fire tube or water tube boilers up to 800hp. There are three modules in the subsystem:

Capacity Control
Trim Control
Monitoring/Reporting

Alarm/Status Reporting—provides digital alarms for N/O or N/C contact points. A unique 40-character message which can be changed from the console tells the operator exactly what happened and what to do. Messages can be directed to remote terminals based on time of day and day of week.

All of the System 90 subsystems employ extensive management reporting to keep the user fully informed of plant operation. All Seaboard™ subsystems offer user defined tables, choice of control sensors, and operational modes changeable throughout the day and/or by control conditions. From the console, the user can change all parameters for all subsystems in a tutorial fashion where the system asks the questions and the user provides the answer. All subsystem interfaces assure safety and integrity of native controls.

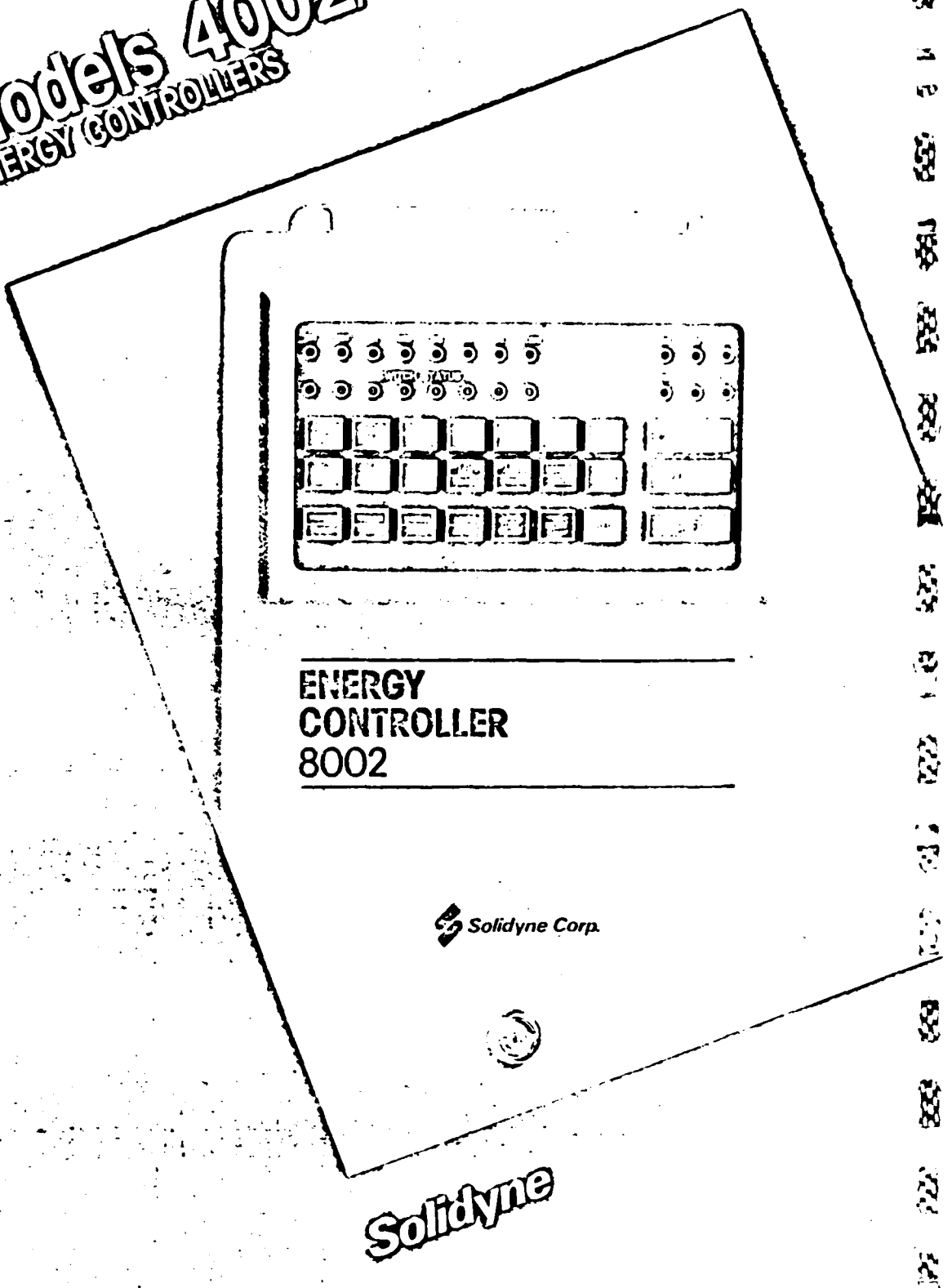
A programmable controller can be an integral part of the System 90 to give total and complete flexibility to the user.

Specification		
Microprocessor:	INTEL 8085A	
System Memory:	64-128KB	
Operating Voltage:	110/240 VAC 60Hz	
Power Consumption:	Max. 150 Watts	
Output Relays:	Solid State OAC5A 3 Amps	
Input Relays:	Solid State IDC5, 25MA 3.32V DC	
Analog Input:	4-20MA, 24 V DC 0-1000 ohms 1000-2000 ohms 0-100 ohms 1-5V DC	(Temperature, Relative Humidity, Pressure, Voltage, Frequency, Current, etc.)
Analog Output:	4-20 MA	
Operating Ambient:	32° F to 120° F 95% RH Non Condensing	
Dimensions:	Height 24" 42" Width, 24" 36" Depth, 9"	
Weight:	25-45 lbs. approx.	

For Additional Information:
Seaboard Energy Systems
4617 Pembroke Lake Circle
Virginia Beach, Virginia 23455
(804) 490-9261

SOLIDYNE CORPORATION

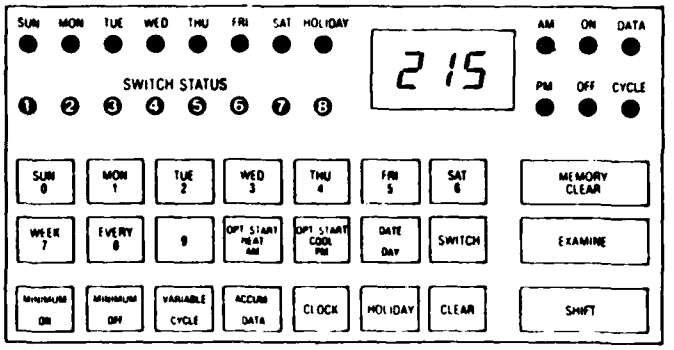
Models 4002/8002
ENERGY CONTROLLERS



The Solidyne 4002 and 8002 Energy Controllers

Standard four and eight channel microprocessor based energy management controllers

Meet the powerful new generation of four and eight channel controllers, the offspring of Solidyne's successful 4000/8000 series. Their exciting new features let you apply to smaller facilities the latest energy management techniques previously reserved only for larger installations. With features like adaptive duty cycling, optimized start, remote communication, etc., these affordably priced controllers can truly squeeze the last dollar of energy savings out of any installation while providing the fastest payback in the industry.

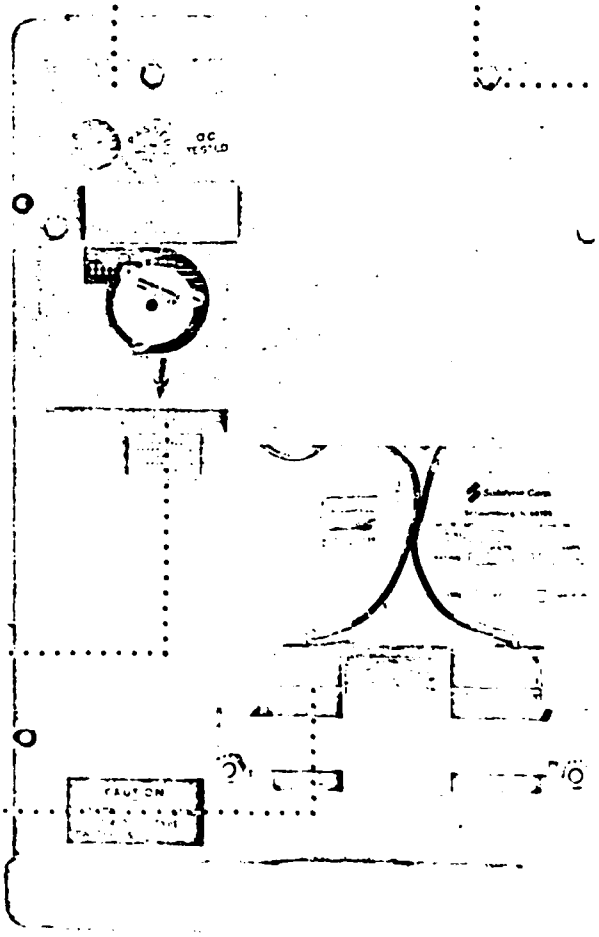


Sealed mylar membrane keypad for program entry and control interface.

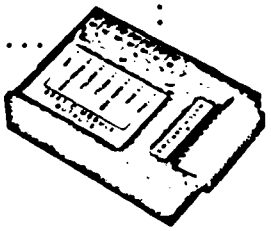
8090
Analog Input Module
(Optional Device. See back pa

Microprocessor

MOD 3
Auto Answer Modem
300 Baud



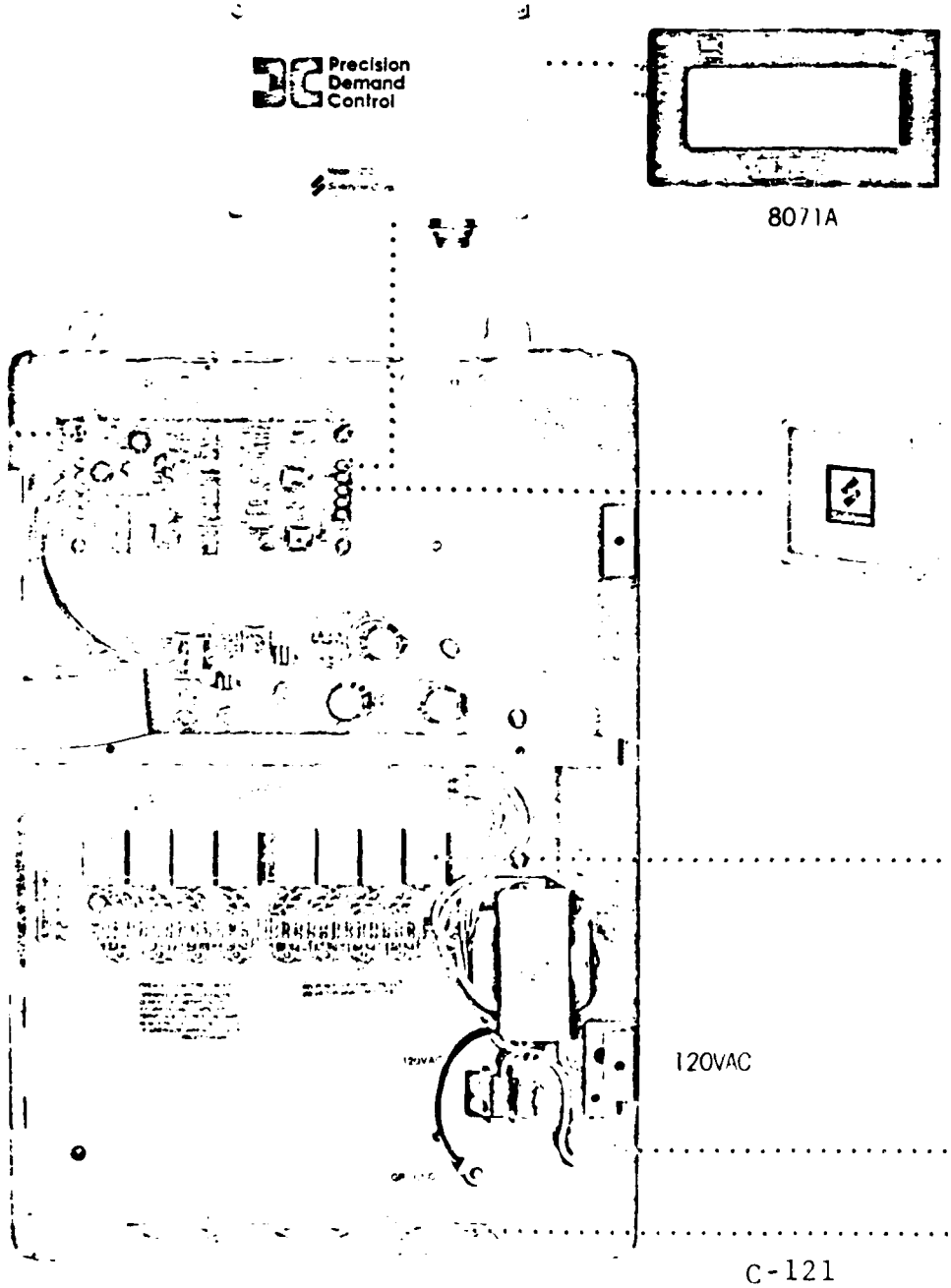
8041
Remote Communication Interface Module. *To interface between 4002 or 8002 controller and telephone modem MOD-3 (Novation J-Cat) installs inside cabinet. Provides remote interrogation and programming capabilities via Apple II or IBM-PC computers.*



Gel-Cel
Rechargeable Battery. Maintains memory during power outage for up to 48 hours when fully charged.

Standard Features:

1. Time-of-day scheduling of 4 or 8 loads
2. Full range duty cycling, 1 to 127 minutes ON or OFF times.
3. Staggered or "rotating load" duty cycling. When several loads are programmed to duty cycle together in this mode, the run times of these loads are automatically spread out evenly over the duty cycle period by the controller to maximize the demand savings.
4. 365-day holiday programming. 16 holidays can be programmed, each lasting up to 127 days.
5. Automatic daylight savings change (may be eliminated if not required).
6. Minimum ON and minimum OFF times are programmable for each load.
7. Maximum OFF times can be programmed for loads under analog control.
8. Relay output logic can be programmed to fail open or closed.
9. Rechargeable battery maintains memory and clock during power failure.
10. Heavy duty locking steel cabinet.



3270
Precision Demand Control. Watt transducer. For accurate demand control and monitoring based on current and voltage sensing. Requires current transformers, one per phase of incoming service (not included). Requires one input on analog module. Mounts externally to 4002/8002 at incoming service.
Size: OD 7 3/4" x 4 1/4" x 1 1/4"

3282C
Temperature Sensor. One required for each analog input used for temperature control. Sensor element may be removed from case and mounted directly into existing thermostat or other enclosure.
Size: 2" x 2" x 1"

4/8 Channel Built-in Relay Outputs. Contact ratings: 5A resistive, 24 VAC, SPDT

ON Override Terminals

Output Spade Terminals

Power Line Filter

Removable Conduit Plate. (Top and bottom of cabinet) for easy replacement

Options for the 4002/8002:

1. **Two Analog Input Board,** Model 8090. This low cost option allows programming any of the loads to turn ON or OFF in response to chosen levels of either analog input. The two analog inputs will accept any analog input signals from Solidyne sensors such as demand controls Model 3270, temperature sensors Model 3282 or humidity sensor Model 3293
2. **Prioritized Demand Control.** Each load's shed level and dead band can be programmed
3. **Kilowatthour accumulation.** With the demand control option installed on one input channel, the controllers will accumulate total kWh usage. The accumulation may be read out locally or remotely over telephone lines using a computer
4. **Optimized start.** This option saves energy by providing the required comfort level at the beginning of occupancy and not before. Optimization is accomplished using inside and outside temperature inputs
5. **Adaptive duty cycling** provides a continuosly varying duty cycle pattern that is determined by the changing levels of one of the analog inputs (temperature, demand, humidity, etc.) This assures maximum savings under all conditions without loss of comfort
6. **Remote Communication** Model 8241. This field installable option allows any Model 4002 or 8002 to be programmed, interrogated, and monitored via telephone by a remotely located computer (Apple II, IBM PC or others compatible) using Solidyne Remote Communication Software

Specifications:

Electrical

Input Voltage: 120VAC, 60 Hz (24 VAC and/or 50 Hz available. Consult factory)
Power Consumption: 24 Watts at 120 VAC
Output Relays: Each channel has SPDT isolated relay contacts, rated 5 Amps resistive at 24 VAC. 2000 VA maximum total on all relays
Circuit Protection: Heat activated fuse in windings of input power transformer
Wiring Connection: Knockouts for 1/2 and 3/4 inch conduit. Connections made to spade terminals and AC power terminal block

Mechanical

Enclosure: Wall mounted heavy gauge steel housing
Finish: Beige textured baked enamel
Dimensions: 13 3/4" x 9 1/2" x 3 3/4"
Weight: 9 pounds

Environmental

Ambient Temperature Range: 32° to 120°F

Operational

Memory Capacity: 144 bytes
Memory Requirement per Program Entry (Note that each entry can control any combination of outputs on any combination of days of the week.)

ON	4 bytes
OFF	4 bytes
DUTY CYCLE	10 bytes
VARIABLE CYCLE	14 bytes
ANALOG CONTROL	11 bytes
OPTIMUM START	10 bytes
HOLIDAY	2 bytes

Battery Backup: Rechargeable battery included provides 48-hour standby operation for clock memory
Clock Timing Accuracy: As accurate as 60 Hz line frequency. On battery standby ± 001%
Max. kWh Accumulation (with demand option) 8 digits

National:
2207 Hammond Drive
Schaumburg, IL 60195
312/397-8500

Eastern Regional:
516/567-3240

South Central Regional:
501/664-1204

Western Regional:
714/988 0615

Order Entry:
1-800/648-3980

Customer Service:
312/397-8500

Electronic Bulletin Board:
(Requires Access Code)
312/397 3477

Telex:
705612

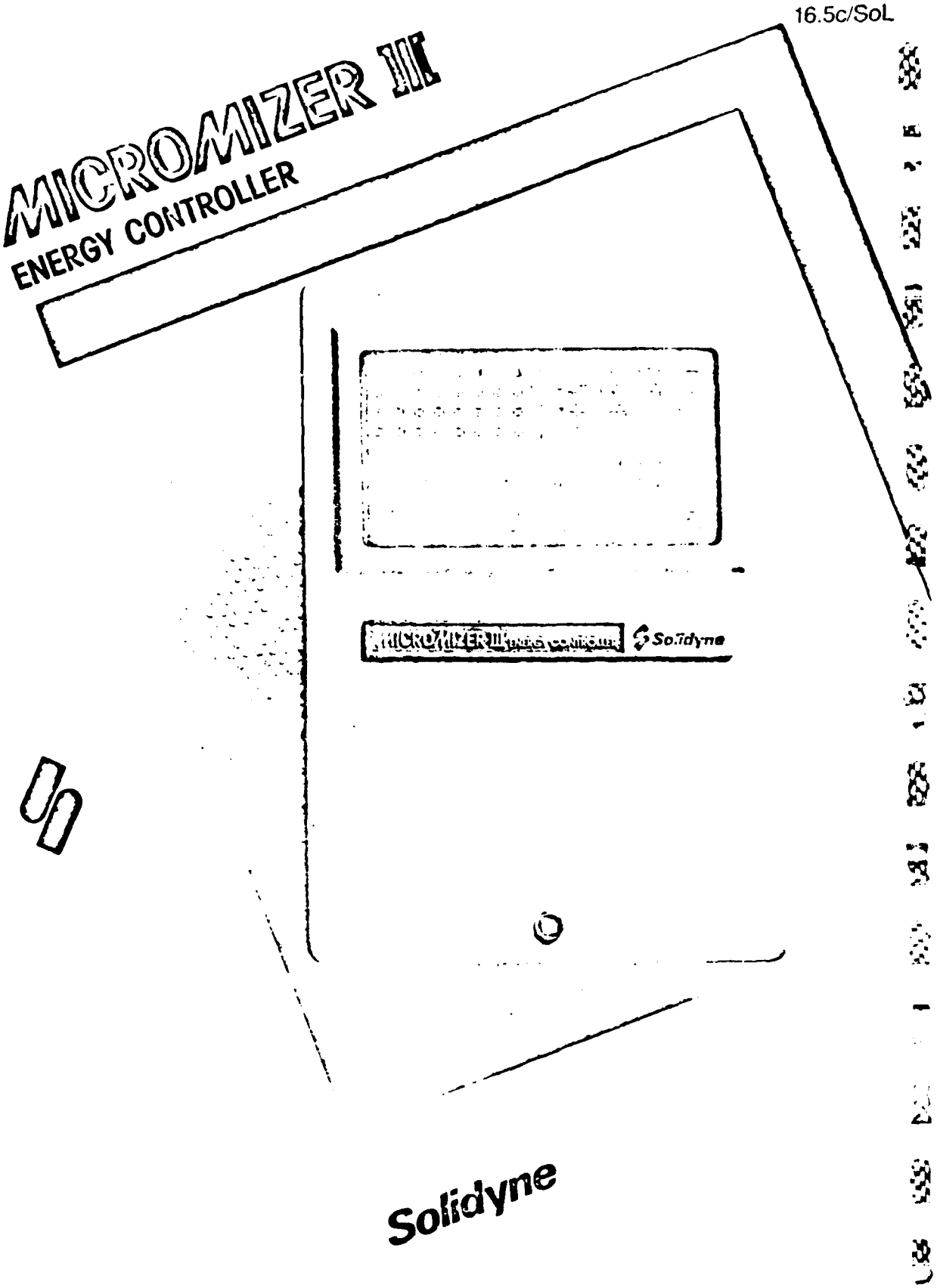
Facsimile:
312/397/3356

SOLIDYNE SAVES ENERGY

16.5c/SoL

MICROMIZER III

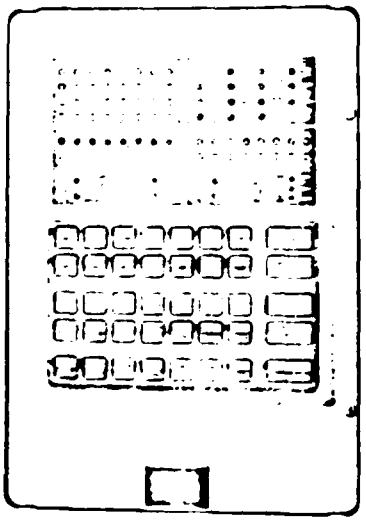
ENERGY CONTROLLER



Solidyne

MICROMIZER III
ENERGY CONTROLLER

Solidyne's exciting third generation of energy controllers has been enhanced to provide even more features that let you apply the most powerful energy management techniques to a broad spectrum of applications. Available with 4 to 32 output channels, and up to 16 input channels, these controllers can provide sophisticated energy control for small, medium, and large size buildings, and at prices that allow an unusually fast payback. Modular design allows optional functions to be added as needed. Programming is simple and user oriented, following the format of Solidyne's first two generations of highly rated controllers.



FEATURES:

STANDARD

- ▲ 32 load capability in increments of 4 or 8 relay outputs.
- ▲ 365 day programmability for holidays.
- ▲ Automatic leap year and daylight savings correction if desired. Daylight savings date programmable.
- ▲ Reversible load relay logic.
- ▲ Programmable relay state when in failure mode.
- ▲ Programmable power failure indicator.
- ▲ Minimum and maximum ON/OFF times can be specified for each load.
- ▲ Sequential load turn on and turn off.
- ▲ Automatic self-initialization after power failure or on new time entry.
- ▲ 50 Hz or 60 Hz operation selectable.
- ▲ Security access code.
- ▲ Switch programmable fail safe relay status.

OPTIONAL
Analog Inputs*

- ▲ 8 or 16 analog inputs.
- ▲ Accepts utility demand pulse inputs with any multiplier factor.
- ▲ Analog inputs can be averaged (sliding window) over a selectable time period.
- ▲ Analog sensor readings can be converted and calibrated through keyboard.
- ▲ Analog sensor readings are scanned and displayed continuously.

Power Line Carrier

- ▲ Integrated 32 channel PLC capability (Requires transmitter)

Voice Prompt

- ▲ Provides verbal help to the operator (Requires speech module)

Remote Communication (Requires interface module)

- ▲ Remote communication capability via phone for program entry, review, modification, and for interrogating recorded data. Programmable phone ring count to delay auto answer.
- ▲ Dial Out capabilities for scheduled or analog alarm conditions.
- ▲ Communication software available for APPLE II, and IBM PC computers.
- ▲ Direct serial printer hook up with print menu.
- ▲ Security code to prevent tampering.

* These options require addition of analog input module(s) plus appropriate sensors or other accessories.

FUNCTIONS:

LOAD CONTROL

STANDARD

- ▲ Time of day ON/OFF schedules.
- ▲ Temporary time of day ON/OFF schedules.
- ▲ Seconds-On function for signaling, pulsing, etc.
- ▲ Automatic rotating load (staggered) duty cycling.

OPTIONAL*

- ▲ Adaptive (self-adjusting, continuously varying) duty cycle controlled by one of the analog inputs (temperature, demand, pressure, humidity, etc.). Winter/Summer switchover automatic.
- ▲ Analog controlled ON/OFF scheduling. Any analog can control any output(s) in a variety of schedules. Winter/Summer switchover automatic.
- ▲ Adaptive (self-adjusting, variable) analog controlled function for chiller and boiler reset, enthalpy control, etc.
- ▲ Self-Learning optimum start/stop functions. Winter/Summer switchover automatic.
- ▲ ON/OFF override input control.
- ▲ Multiple unit daisy chain capability for applications that require more than 32 outputs and/or more than 16 analog inputs.

DATA GATHERING

STANDARD

- ▲ Run time of all outputs recorded up to 10,000 hours in one minute increments.

OPTIONAL (with override modules)

- ▲ Run time of all override inputs recorded up to 10,000 hours in one minute increments.

OPTIONAL (with analog inputs)

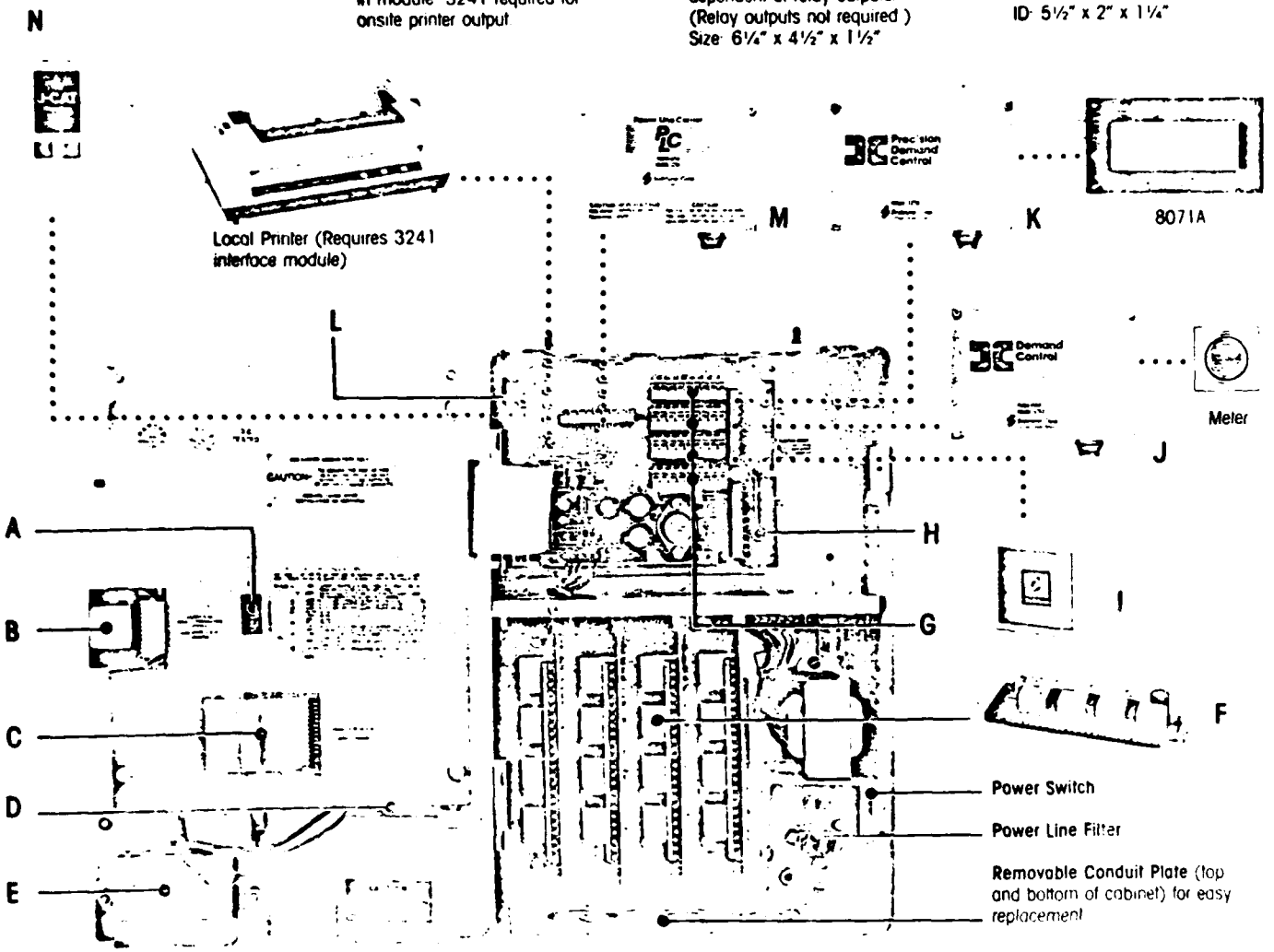
- ▲ First eight (8) analog inputs will record maximum or minimum readings for the past 35 days.
- ▲ First two (2) analog inputs will record 48 hour, 15 minute averaged readings.
- ▲ kWh or other analog time accumulation for all 16 analog inputs up to 99,999,999.

N. Mod-3:
Auto Answer & Dial Out Modem, 300 Baud

L. M42
Remote Communication Interface Module. For interfacing between Micromizer III and tele phone modem MOD-3, (Novation J-Cat) Installs inside Micromizer III cabinet Provides remote interrogation and programming capability via APPLE II or IBM PC computers Alarm Dial-Out to remote monitoring computer Plug-in module 3241 required for onsite printer output

M. 3290
Power Line Carrier Transmitter. Provides 32 channels of PLC transmission to receivers at controlled equipment Mounts external to Micromizer III at power distribution panel Connects to Micromizer III via 2 wire shielded cable Output connects to all 3 phases of power line PLC operates simultaneously with but independent of relay outputs (Relay outputs not required) Size 6¼" x 4½" x 1½"

K. 3270
Precision Demand Control. Watt transducer For accurate demand control and monitoring based on current and voltage sensing Requires current transformers, one per phase of incoming service (not included) Requires one input on analog module Mounts externally to Micromizer III at incoming service
Size OD 7¾" x 4⅛" x 1¼"
ID 5½" x 2" x 1¼"



A. Program Switches
for option selections

B. M50
Speech Module. Generates verbal help for programming prompting, review and alarm Plug in module

C. Optional Memory Modules.
M43A Provides additional memory required for alarm dial out and on site printer

M46A. Standard operating software

D. Future Expansion Bus

E. Gel-Cel
Rechargeable Battery

F. 3208R
Eight Channel Relay Output Board. Plugs into basic Micromizer III unit Output contact rating 5A resistive, 24v, SPDT Hard wire override terminals for each channel Four channel 3204R Relay Output Board is also available

G. M87
Override Modules (Up to 4). Each provides 8 channels of override function, PLC override, and override on time accumulation, by means of external contact closures Plug-in modules

H. M85
Analog Input Modules (2 max.). Each accepts 8 inputs from analog sensors or discrete (contact closure) inputs Plug in modules

I. 3282C
Temperature Sensor One required for each analog input used for temperature control Sensor can be field recalibrated through keypad Sensor element may be removed from case and mounted directly into existing thermostat or other enclosure
Size 2" x 2" x 1"

J. 3283
Pulse Input Demand Control
Uses power company's pulse initiating meter to accurately determine demand Mounted external to Micromizer III cabinet at incoming service Requires one input on analog module
Size 6¼" x 4½" x 1½"

Options with "M" prefix are modules designed for direct plug in inside the Micromizer III Model 3203 Relay boards (3208R, 3204R) also are plug in All other series 3200 options are wired to the Controller from an external location

Other analog sensors, such as humidity and pressure are also available

Micromizer III
Specifications

Electrical

Input Voltage: 120 VAC, 50 or 60 Hz selectable (24 VAC available Consult factory.)

Power Consumption: 24 Watts at 120 VAC

Output Relays: Each channel has SPDT isolated relay contacts, rated 5 Amps resistive at 24 VAC 2000 VA maximum total on all relays

Circuit Protection: Heat activated fuse in windings of input power transformer Line transients suppressed by special filter

Wiring Connection: Knockouts for ½ and ¾ inch conduit in removable plate Connections made to screw terminal blocks

Mechanical

Enclosure: Wall mounted heavy gauge steel housing

Finish: Beige textured baked enamel

Dimensions: 13¼" x 9½" x 3¾"

Weight: 15 pounds

Environmental

Ambient Temperature Range: 32° to 120°F

Operational

Memory Capacity: 4000 characters (bytes)

Battery Backup: Rechargeable batteries provide 8 days standby operation for clock and memory

Clock Timing Accuracy: As accurate as 60 Hz line frequency On battery standby ± 001%

Max. kWh Accumulation (with demand option): 8 digits

* Specifications subject to change without notice

Solidyne

2207 Hammond Drive
Schaumburg, IL 60195
Telephone 312-397-8500
Telex 705612

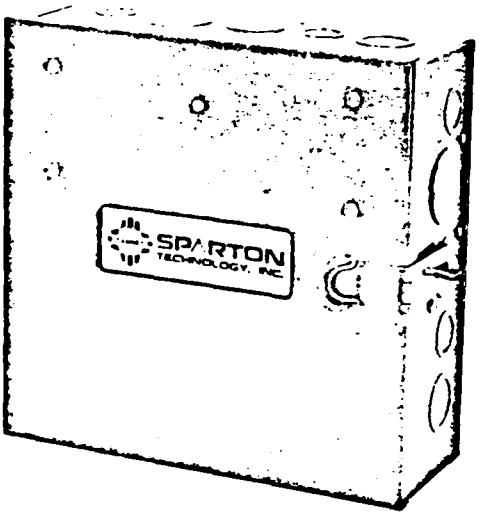
SOLIDYNE SAVES ENERGY

SPARTON TECHNOLOGY, INC.

SPARTON™

MICRO FIELD MULTIPLEXER PANEL

MODEL 5441
A 5400 CAMNET® BUILDING BLOCK
21 INPUT / OUTPUT POINTS



OUTSTANDING FEATURES

- Operates on a stand-alone basis as a control and monitoring station
- No coax cable — inexpensive twisted pair wiring to input/output points
- Simple to operate with English commands
- Automatic monitor and control functions are part of the system
- ASCII RS232C communications with automatic baud rate detection
- Automatic telephone answering and dialing for remote capability using integral modem/dialer
- Standard industrial interfaces for input/output points
- Monitors contact and transducer alarms with user-programmable limits
- 8-day clock for day/date/time output control with advance selection of daylight savings time
- Microprocessor-based design

DESIGNED FOR ENERGY MANAGEMENT, PLUS MAINTENANCE AND SECURITY MONITORING

- **ENERGY MANAGEMENT:** Can be user programmed for:
  (1) Separate time-of-day scheduling for each load and each day plus up to 15 holidays
  (2) Duty cycling in 5-minute increments of selected loads
  (3) Night setback for winter or setup for summer
  (4) Peak demand monitoring with load-shedding control
  (5) Thermostatic equipment control capabilities
  (6) Optimum Start
  (7) Proportional analog outputs
- **MAINTENANCE MONITORING:** Automatically:
  (1) Reports equipment failures locally or remotely
  (2) Maintains equipment runtime totals
  (3) Provides notification of scheduled maintenance
- **SECURITY MONITORING:** Magnetic door switches, smoke alarms, and other contact closures can be automatically monitored
- **TELEPHONE INTERFACE:** Via the standard dial-up telephone network:
  (1) Allows access from a remote terminal so that many 5441's can have a central control station
  (2) Provides for automatic alarm transmission to a remote maintenance facility with workday and weekend phone number scheduling
- **SYSTEM ALARMS:** Automatically reports locally or remotely:
  (1) Failures of equipment to go on or off
  (2) Input measurements that are outside programmed limits
  (3) Status change on alarm contact inputs
  (4) Runtime limits exceeded
  (5) For after-hours alarms, a different phone number can be designated if desired
  (6) Power failure alarm
- **SYSTEM REPORTS:** Can be manually initiated or automatically printed out at user-programmed times for data collection
- **SYSTEM SECURITY:** A three level password system permits only authorized personnel to operate the 5441

CAMNET®

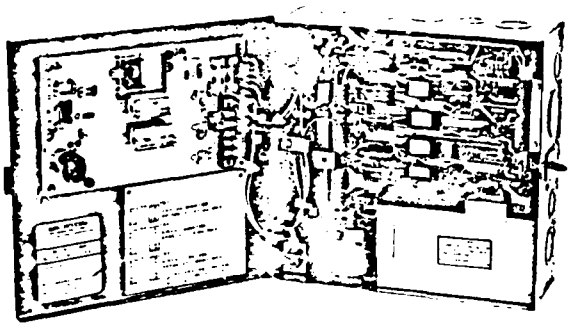
3M 5441-12 85

SPARTON TECHNOLOGY, INC.

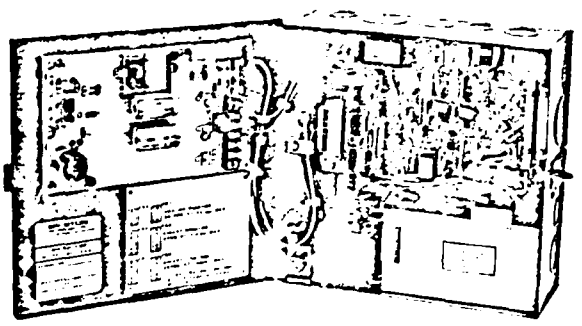
Subsidiary of SPARTON CORPORATION

MAIN OFFICE 4901 Rockaway Blvd., S.E. / Rio Rancho, New Mexico / Phone (505) 892 5300 / TWX 910 989 1657
MAILING ADDRESS P.O. Box 1784 / Albuquerque, New Mexico 87103

IN CANADA arton of Canada Ltd / Box 5125 / London, Ontario N6A 4N2 / PHONE 519 455 6320



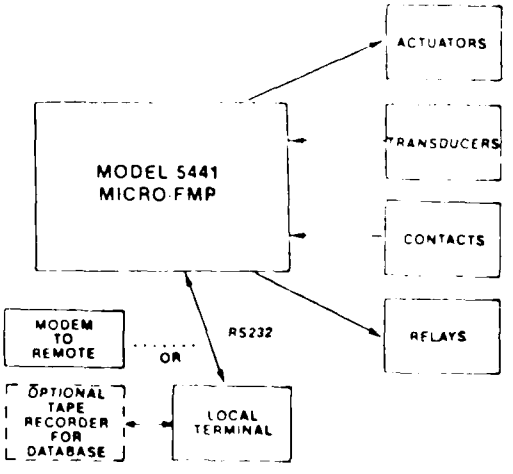
5441 with Power Supply and Battery Backup



5441 with Power Supply, Battery, and Modem/Dialer

SPECIFICATIONS

8 BINARY INPUTS:	(1) Normally open or normally closed contact points. (2) TTL compatible voltage levels (+ 5v) or open collector drivers.
8 BINARY OUTPUTS:	Capacity to sink 100 milliamperes at up to 30 volts continuously.
4 ANALOG INPUTS:	Selectable— (1) 0-5 volts DC with an input impedence of 1000 ohms. (2) 0-10 volts DC with an input impedence of 2000 ohms. (3) 4-20 milliamperes DC with an input impedence of 250 ohms.
1 ANALOG OUTPUT:	Selectable— (1) 4-20 milliamperes DC current sink into a load of up to 500 ohms. (2) 2-10 volts DC into a load of 5,000 ohms or greater.
ANALOG ACCURACY:	± 1% of full scale value.
POWER SUPPLY:	115 VAC, 0.3 Amps, to a wall plug-in transformer providing 20 VAC, 2.0 Amps to the unit, 24VDC, .5A available for binary output, analog output, and analog input transducers. 8 hr. battery backup for computer; 4 hour with integral modem/dialer
OPERATING ENVIRONMENT:	(1) Temperature: — 20°F to 120°F (— 30°C to 49°C). (2) Humidity: 0-95% non-condensing.
COMMUNICATIONS:	ASCII RS232C automatic selection for 110, 300, 1200, 2400 and 4800 baud. For remote communications via the direct distance dial telephone network, an optional Sparton-designed modem/dialer can be installed in the 5441. See photo above.
ENCLOSURE:	Locking NEMA-1, 10.25" high x 10.25" wide x 4" deep.
WEIGHT:	7.5 pounds not including batteries.



SQUARE D COMPANY

Revised Nov., 1985

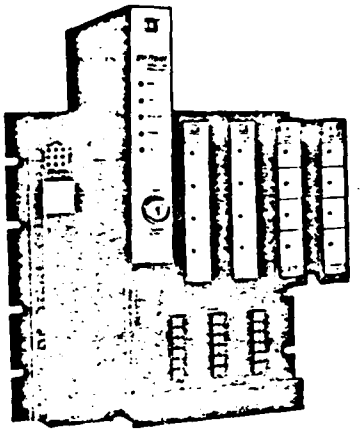
SY/MAX® PROGRAMMABLE CONTROLLERS
INTRODUCTION

CLASS 8010 8020 8030 8040

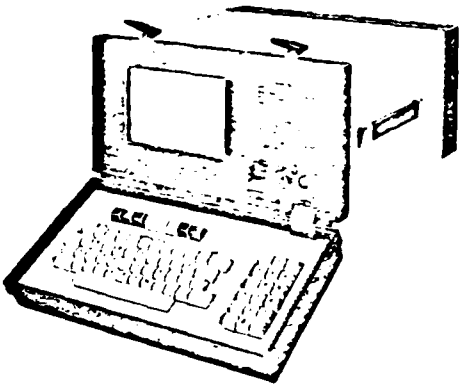
GENERAL

Programmable controllers are used in a variety of applications to replace conventional control devices such as relays and solid state logic. When compared with conventional control means, programmable controllers (PC's) allow ease of installation, quick and efficient system modifications, more functional capability, troubleshooting diagnostics and a high degree of reliability. Typical applications include automated material handling, machine tool, and assembly machine control, wood and paper processing control, injection molding machine control and process control applications such as film, chemical, food, and petroleum.

The SY/MAX designation is used to describe a family of programmable controller equipment. Family members include processors, input-output equipment, programmers and peripheral equipment developed to be interchangeable with other family members. Process control equipment is also part of the SY/MAX PC Family of devices.



SY/MAX Model 300 Programmable Controller



SY/MAX CRT Programmer

SYSTEM HARDWARE AND PROGRAMMING EQUIPMENT

The SY/MAX Programmable Controller Family consists of two groups of equipment: 1) system hardware and 2) programming equipment. System hardware is used to control the actual operation, while the programming equipment is used to enter the user control program into the system hardware. Once the program is entered the programming equipment can be used for monitoring, program alteration, or message displays but is not required for system operation.

SYSTEM HARDWARE

System hardware consists of a processor, one or more rack assemblies, power supplies, Input/Output modules, and various other modules that provide additional capabilities. The rack assemblies and associated I/O modules communicate with external I/O control devices such as limit switches, motor starters, etc. System hardware may also consist of a single Model 100 PC which incorporates all necessary hardware in a single package.

PROGRAMMING EQUIPMENT

The SY/MAX PC Family programming equipment consists of either a Hand-Held, Standard CRT, Deluxe CRT, or IBM programming package used during program entry or for monitoring the operation of the system. A separate Loader/Monitor for monitoring and changing data or printing messages can also be ordered.

SUPPORT LITERATURE

Support literature in the form of Technical Manuals, and individual Instruction Bulletins is available for the SY/MAX Programmable Controller Family.

SY/MAX TECHNICAL MANUALS

SY/MAX Programmable Controller Technical Manuals include a collection of Instruction Bulletins in a convenient 3-ring binder format (see Instruction Bulletin table page 4 to determine which Instruction Bulletins are included in each Technical Manual). This format allows easy updating of technical manuals as new products and literature are introduced.

Description	Part Number
Processor Technical Manual	30598 501 50▲
Comprehensive Class 8010 8020 8030 & 8040 Technical Manual	SM-600

* Latest Technical Manual available will automatically be supplied. Subsequent revisions change
▲ Included with each Processor

SY/MAX® PROGRAMMABLE CONTROLLERS

INTRODUCTION — Cont'd

Class 8010 8020 8030 8040

Class & Product Category	Type	Description	Number ①	Included in Technical Manual 30598-501-50	Included in Technical Manual 30598-SM 605
8010 Communication & Documentation Software	SFW-301	Communications Software for DEC PDP Computers	30598-290-02		
	SFW-302	Documentation Software	30598-290-02 ②		
	SFW-302	for	30598-291 02 ②		
	Form RL1	DEC	30598-292-02 ②		
	SFW-302	PDP	30598-292-03 ②		
	Form RX1	Computers	30598-293-02 ②		

① Latest Instruction Bulletin available will automatically be supplied — suffix number may change. Individual Instruction Bulletins are available on a no charge basis. For a complete set, order the Comprehensive Technical Manual from above.
② Included with each Class 8020 Model 100 Programmable Controller
③ Included with Software
④ Included with Programmer

Class & Product Category	Type	Description	Number ①	Included in Technical Manual 30598-501-50	Included in Technical Manual 30598-SM 605
8010 Communication & Documentation Software	SFW-307	Documentation	30598-291-02 ④		
	SFW-307	Software	30598-292 02 ③		
	Form RL1	for	30598-292 03 ③		
	SFW-307	DEC	30598-293-02 ④		
	Form R800	VAX			
	SFW-307	Computers			
	Form 1600				
	SFW-311	XYCOM Documentation Software	30598-171-01 ③		
	SFW-321	SY/MAX Communications Software for IBM Personal Computers	30598-310-01 ③		X

⑤ Included with each Class 8010 Type SPR-100 Hand-Held Programmer
⑥ Included with each Class 8010 Type SLM-100 Loader/Monitor
⑦ Included with each Class 8010 Type SLR-100, 110 Cartridge Tape Loader/Recorder

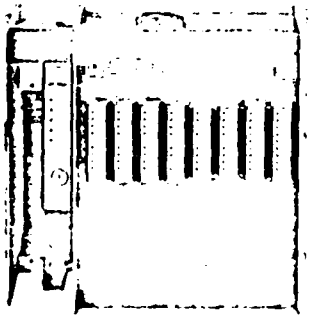
PROGRAMMABLE CONTROLLER/PROCESSORS

GENERAL PROGRAMMABLE CONTROLLER CAPABILITIES

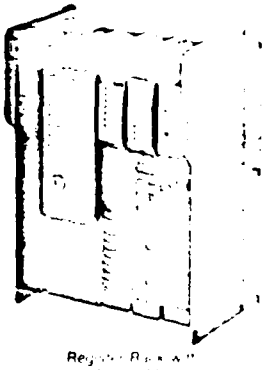
All SY/MAX PC processors have the following capabilities: relay logic, latch/unlatch relays, data transfer, timers, counters, master control relay, synchronous shift register, data comparisons, bit read and control, transitional output, register fencing, respond to communications from other processors, and I/O forcing. The table below indicates additional features of SY/MAX PC processors.

	Model 100 PC	Model 300 Processor		Model 500 Processor	Model 700 Processor
		Standard	Deluxe		
Memory Size (Words)	420	½K, 1K, 2K		2K, 4K, 8K	8K, 16K, 32K, 64K
Memory Type	RAM or UV PROM	RAM	RAM and/or UV PROM	RAM and/or UV PROM	RAM with Bubble Back-up
Nominal Scan Rate (Per 1K)	40ms (½K)	30ms (Ladder)		2ms (Ladder)	1.3ms (Ladder)
I/O Capacity	40	256 typical		over 2,000	over 8,000
Digital I/O Voltages	120 VAC	TTL to 240 VAC, 250 VDC		TTL to 240 VAC, 250 VDC	TTL to 240 VAC, 250 VDC
Analog I/O	—	YES		YES	YES
Remote I/O	—	YES		YES	YES
Relay Equivalents	64	128		over 2,000	over 8,000
Storage Registers	38	96		2,000	8,000
PID Control	—	—	YES	YES	YES
Distributed Control	YES	YES		YES	YES
Asynchronous Shift	—	—	YES	YES	YES
Math (+ − × ÷)	—	—	YES	YES	YES
Square Root	—	—		YES	YES
Abs. Value, Sine, Cosine, Log_{10}, LN_e, $(Y)^x$	—	—		—	YES
Print (Alpha-Numeric Messages)	—	—	YES	YES	YES
Initiate Communications	—	—	YES	YES	YES
Run Mode Programming	—	YES		YES	YES
Scan Control	—	—		YES	YES
Matrix Operations	—	—		YES	YES
Floating Point Math	—	—		—	YES
Memory/Register Security Access (Password)	—	—		—	YES

SY/MAX Model 100 Programmable Controller



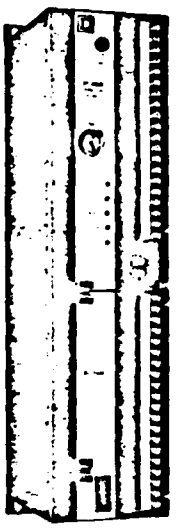
SY/MAX MODEL 300 and 8 Function I/O



Register Base Assembly Model 500

SY/MAX® PROGRAMMABLE CONTROLLERS
PROGRAMMABLE CONTROLLER/PROCESSORS

SY/MAX MODEL 100 PROGRAMMABLE CONTROLLER



SY/MAX Model 100 Programmable Controller

The SY/MAX Model 100 Programmable Controller is a completely self contained PC with integral processor, power supply and I/O. There is a choice of a 20 I/O (12 inputs, 8 outputs) or 40 I/O (24 inputs, 16 outputs) package. It can be ordered with either 420 words of RAM memory with battery back-up or UV PROM Memory. The Model 100 PC is capable of either vertical or horizontal mounting. It's label is configured for vertical mounting. If horizontal mounting is preferred order the optional Horizontal Label Set. For minimum height the Model 100 PC may be mounted on it's side. Order the Low Profile Mounting Bracket set.

Description*	Class	Type
Programmable Controller with 12 Inputs, 8 Outputs, and 420 Words RAM Memory	8020	SCP-111
Programmable Controller with 24 Inputs, 16 Outputs, and 420 Words RAM Memory	8020	SCP-121
Programmable Controller with 12 Inputs, 8 Outputs, and 420 Words UV PROM Memory	8020	SCP-112
Programmable Controller with 24 Inputs, 16 Outputs, and 420 Words UV PROM Memory	8020	SCP-122
Spare Model 100 RAM Memory Module	8020	SMM-100
Spare Model 100 UV PROM Memory Module	8020	SMM-110
Replacement Battery for use in Model 100 Programmable Controller	8020	SMM-115
Fuse Kit for Model 100 10 Fuses	8020	SFK-210
Low Profile Mounting Bracket Set	8020	SMB-120
Horizontal Label Set	8020	SMB-130

* All I/O are rated for 120 VAC operation and utilize the same power source. See Appendix A for power ratings

SY/MAX MODEL 300 PROCESSOR

The Model 300 processor is mounted into the CPU slot of a digital I/O or register rack assembly and is available in two versions: Standard and Deluxe.

The Standard version can be supplied with ½K, 1K or 2K RAM memory, with I/O capacity of 256. The processor has 128 internal relay equivalents and 96, 4 digit storage registers for timers, counters, synchronous shift registers, and data storage. A single communication port is available for use with CRT or Hand-Held programmer, Loader/Monitor or Loader/Recorder, or direct connection to a Deluxe Model 300 or Model 500 processor.

The front panel has a security keyswitch to select RUN, HALT, or DISABLED OUTPUTS modes of operation. It also has five status indicator lights.

The Deluxe processor includes all capabilities of the Standard Processor plus the following: 1K and 2K UV PROM Memory Versions, Asynchronous shift register; 4 function math; PRINT (alpha-numeric message generation); WRITE (enter data into other Processor); READ (obtain data from other Processor); and ALARM (send preset codes to other Processors). The Deluxe processor provides two communication ports.

SY/MAX Model 300 Processor

Description	Class	Type
Standard Processor with ½K RAM Memory	8020	SCP-311
Standard Processor with 1K RAM Memory	8020	SCP-312
Standard Processor with 2K RAM Memory	8020	SCP-313
Deluxe Processor with ½K RAM Memory	8020	SCP-321
Deluxe Processor with 1K RAM Memory	8020	SCP-322
Deluxe Processor with 2K RAM Memory	8020	SCP-323
Deluxe Processor with 1K UV PROM Memory	8020	SCP-332
Deluxe Processor with 2K UV PROM Memory	8020	SCP-333
Deluxe Processor with 1K RAM, 1K UV PROM Memory	8020	SCP-344
Model 300 Label Kit	8020	SLK-310

SY/MAX® PROGRAMMABLE CONTROLLERS

APPENDIX A — I/O SPECIFICATIONS & POWER SUPPLY LOADING — Cont'd

Class	Type	I/O Voltage Rating	Voltage Operating Range	Maximum Output Load Current①	PC Power Supply Loading		Rack Compatability				
					75% Duty Cycle	100% Duty Cycle	CRK	DRK	GRK	HRK	RRK
8020	SCP-1XX	120 VAC	94-132 VAC 50/60Hz	2A	NA	NA	NA	NA	NA	NA	NA
8020	SCP-311	NA	NA	NA	1500mA	1500mA④	X	X	X	X	X
8020	SCP-312	NA	NA	NA	1500mA	1500mA④	X	X	X	X	X
8020	SCP-313	NA	NA	NA	1500mA	1500mA④	X	X	X	X	X
8020	SCP-321	NA	NA	NA	1500mA	1500mA④	X	X	X	X	X
8020	SCP-322	NA	NA	NA	1500mA	1500mA④	X	X	X	X	X
8020	SCP-323	NA	NA	NA	1500mA	1500mA④	X	X	X	X	X
8020	SCP-332	NA	NA	NA	2000mA	2000mA④	X	X	X	X	X
8020	SCP-333	NA	NA	NA	2000mA	2000mA④	X	X	X	X	X
8020	SCP-344	NA	NA	NA	2000mA	2000mA④	X	X	X	X	X
8020	SCP-5XX	NA	NA	NA	4000mA	4000mA④	–	–	–	–	X
8020	SCP-7XX	NA	NA	NA	4300mA	4300mA④	–	–	–	–	X
8020	SMM-710	NA	NA	NA	2000mA	2000mA④	–	–	–	–	X
8020	SMM-720	NA	NA	NA	2200mA	2200mA④	–	–	–	–	X
8010	SLM-100	NA	NA	NA	600mA	600mA	NA	NA	NA	NA	NA
8010	SPR-100	NA	NA	NA	1000mA	1000mA	NA	NA	NA	NA	NA
8040	PCM-110	NA	NA	NA	2000mA	2000mA④	–	–	–	–	X

① A maximum of 10 of these type modules (indicated by ④) can be powered from a single power supply
NA Non Applicable

APPENDIX B — CLASS 8030 POWER SUPPLY SPECIFICATIONS

For proper operation the correct power supply must be used with a SY/MAX programmable controller system. Power supplies with an incoming voltage of 120 VAC, 240 VAC and 24 VDC are available. Use the Table in Appendix A to calculate the total load the power supply will be required to handle. A 75% duty cycle means that 75% of the I/O are "on" at any given time. The majority of applications fall into the 75% duty cycle category. With few exceptions a power supply rated at 64 I/O will be able to handle 64 I/O. Model 100 Programmable Controllers and SY/MAX-20 Processors have integral power supplies and thus do not need an external supply.

Power Supply Type	PS-10	PS-20	PS 30		PS 40	PS 50	PS 60		PS-70
Input Voltage Range	102-132 VAC ✱				204 250 VAC ✱	195 250 VAC ✱			22 5 28 VDC
Approximate I/O Capacity	64	128	512		64	128	512		128
Output Voltage Range	5 15-5 25 VDC		5 15-5 25 VDC	12 4-12 6 VDC	5 15 5 25 VDC		5 15-5 25 VDC	12 4-12 6 VDC	5 15-5 25 VDC
Output Current Capacity @ 0-40°C	4A	12A	23A	2 2A	4A	12A	23A	2 2A	10A
Output Current Capacity @ 40-50°C	4A	9A	20 2	1 9A	4A	9A	20 2	1 9	10A
Output Current Capacity @ 50-60°C	3A	7A	17 4	1 6A	3A	7A	17 4	1 6	7A

✱ 47 63 Hz

APPENDIX C — PROGRAMMING EQUIPMENT, I/O, AND PROCESSOR COMPATIBILITY

Group	Class	Type	Processors				
			Class 8020 Model 100	Class 8020 Model 300	Class 8020 Model 500	Class 8020 Model 700	Class 8040 PCM-110
CRT Programmers	8010	SPR-201 211	X	X	X	X④	X
	8010	SPR-250 260	X	X	X	X⑤	X
	8010	SPR 300 310	X	X	X	X⑥	X⑥
Hand-Held Programmer	8010	SPR-100	X	X	X	X	NA
Loader/Monitors	8010	SLM-100	X	X	X	X	NA
Process Control Station	8040	PCM-902	NA	NA	NA	NA	X
Loader/Recorders	8010	SLR-100, 110	X	X	X	X	X①
UV Prom Eraser	8010	SLR-150	X	X	X	NA	NA
Printers	8010	PP-12	X②	X③	X③	X③	X⑦
	8010	PP-13	X②	X③	X③	X③	X⑦
I/O	8030	I/O	NA	X	X	X	X⑦

X = Totally Compatible
NA = Not applicable
① Requires a Class 8010 CRT as interface
② Requires a Class 8010 CRT to print ladder diagram programs, or can be connected to a Deluxe Model 300, Model 500 or Model 700 Processor or D-LINC Module (Class 8010 Type CRM-600 or CRM-601 Adapter required) to print messages
③ Can be connected directly to a Deluxe Model 300, Model 500 or Model 700 Processor, D-LINC Module or to a Class 8010 CRT
④ Not all Model 700 instructions are supported
⑤ Must be Series I (Rev. 2.6) or later to program Floating Point numbers
⑥ Must be Series I (Rev. 2.6) or later to use SFW-100 Executive
⑦ Used with Analog I/O Modules only. For PID (or not) with PCM Analog Input (HMA-121), Module should be Series C or later

SYNERGETICS INTERNATIONAL, INC.

ZDC COMMERCIAL ENERGY SENTRY®

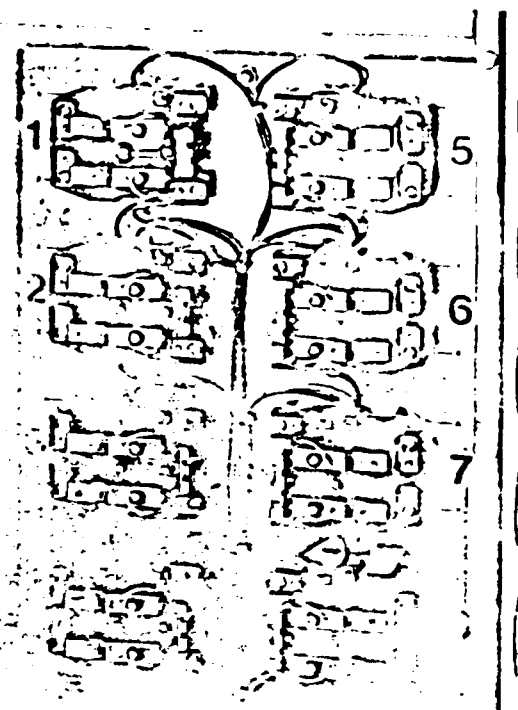
SYSTEM COMPONENTS & SPECIFICATIONS

AT LAST

— a demand based energy management system that controls KW demand, allows you to dial in more or less energy as needed with a single control adjustment, manages up to 16 loads, and is low cost. Perfectly suited for controlling energy costs in:

Office condominiums
Fast food chains
Restaurants
Retail establishments
Convenience stores
Light commercial/industrial
Large residential

NO MORE monthly utility bill "surprises!" Control your electricity costs to your budget!



SYSTEM OVERVIEW

The Energy Sentry Commercial Demand Controller automatically controls peak kilowatt demand by temporarily deferring certain low priority circuits. These non-critical circuits are deferred during the time the critical business circuits are in use. By deferring the non-critical circuits, KW demand charges are controlled to a predetermined absolute minimum. Depending upon actual application, the most common circuits to be controlled by the Energy Sentry System are: electrical heating, air conditioning, water heaters, coolers, steam tables, bun warmers, air compressors, chillers, process heaters, dryers, battery chargers, air handlers, etc.

All circuits to be controlled are assigned a high to low priority value dependant upon each circuit's relative importance to business function or comfort. Energy Sentry will automatically defer the lowest priority circuit first, the highest priority circuit is the last to be deferred. In turn, the highest priority circuit is the first to be restored and so on. Energy Sentry's Logic module will only defer circuits as required to keep average KW demand from exceeding a predetermined level.

All Energy Sentry models are equipped with a "rotate priority" option (field selectable) which allows up to 4 circuits to be controlled on an equal priority basis. Thus, up to 4 controlled circuits may be assigned equal priority positions.

COMPONENTS

An Energy Sentry Commercial Demand Control system consists of the following system components:

A. Control Unit (4 to 16 circuits)*
B. Control Panel (Alpha, ES or SC)*
C. Current Transformers (3 required for 3 phase applications)
D. Watt Converter
E. Potential Transformers (only required for some limited applications)
F. Options*

*See System Components and Specifications for the Energy Sentry Residential Controllers to find general specifications, control unit, control panel, housings and system options.

SPECIFICATIONS

CURRENT TRANSFORMERS

MECHANICAL

Each application	Three required
Type	Ring (standard) Split (optional)
Sizes available	Standard - 1⅛" ID x 2⅜" OD (up to 500 MCM) Large - 3" ID x 4½" OD

ELECTRICAL

Ratios available	200:5, 400:5,

FEATURES AND BENEFITS

- Current Transformer wiring may be configured to readily adapt control unit to multiple service entrances or multiple circuit breaker panels

WATT CONVERTER

MECHANICAL

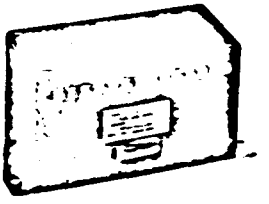
Dimensions	7½" x 4⅝" x 3½"
Terminals	14-screw type

ELECTRICAL

Voltage input	120V
Max output	20V DC

FEATURES AND BENEFITS

- The watt converter adapts the Energy Sentry to three phase service



POTENTIAL TRANSFORMERS

MECHANICAL

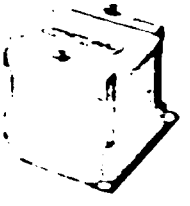
Dimensions	5¼" x 4¾" x 4"
Terminals	4 screw type

ELECTRICAL

Input Voltage	240V or 277V
Output Voltage	120V AC

FEATURES AND BENEFITS

- The potential transformers convert the service voltage to 120V A.C. for input into the watt converter



STANDARD CONTROL RANGES

0-30 KW
0-60 KW

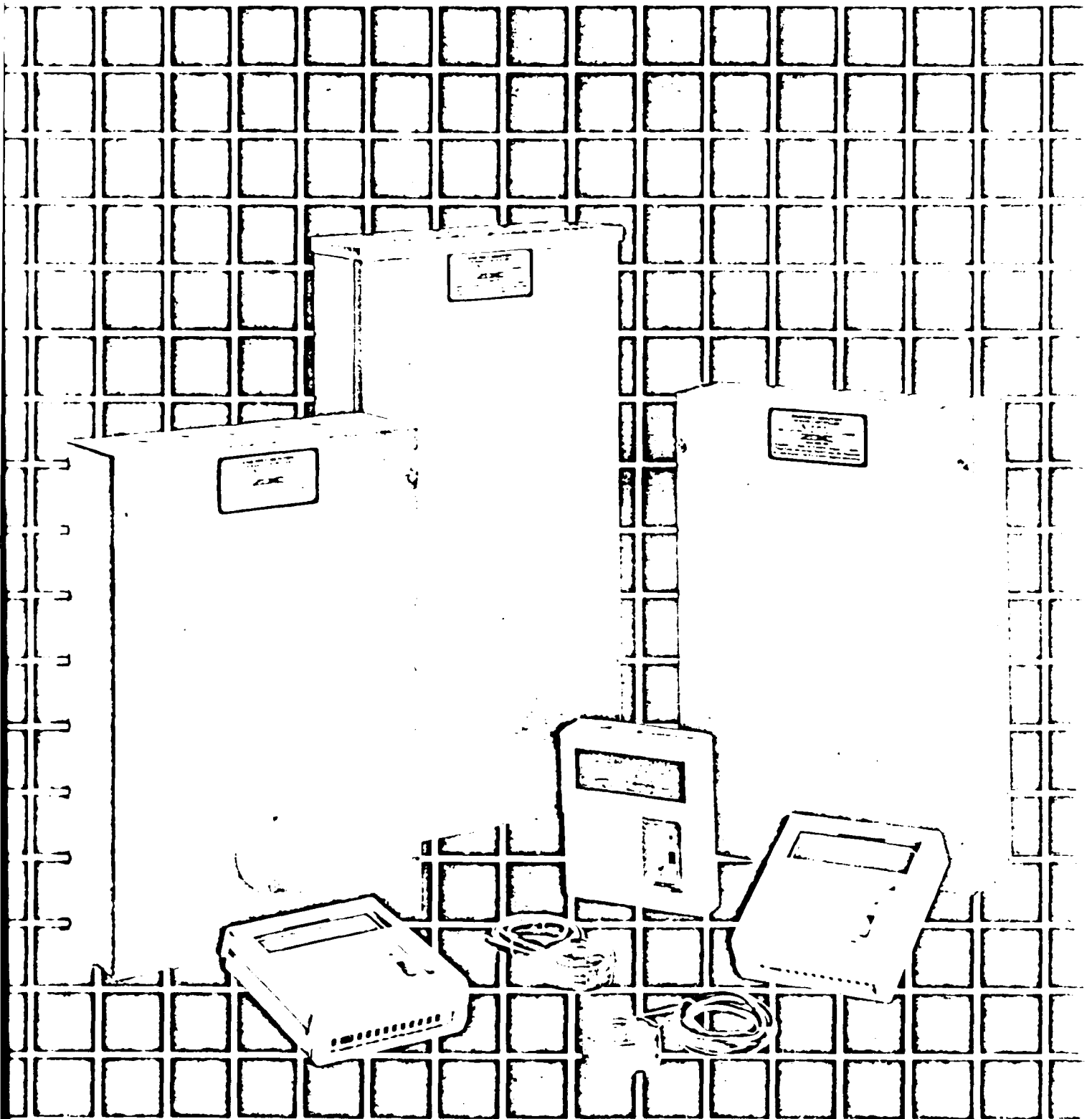
ORDERING INFORMATION

See "Energy Sentry Commercial Demand Controller Installation and Electrical Survey Form" for details. For further information, call or write ZDC, Incorporated.

FOR FURTHER INFORMATION, CONTACT:

ZDC ENERGY SENTRY

SYSTEM COMPONENTS & SPECIFICATIONS



CONTROL UNIT

MECHANICAL

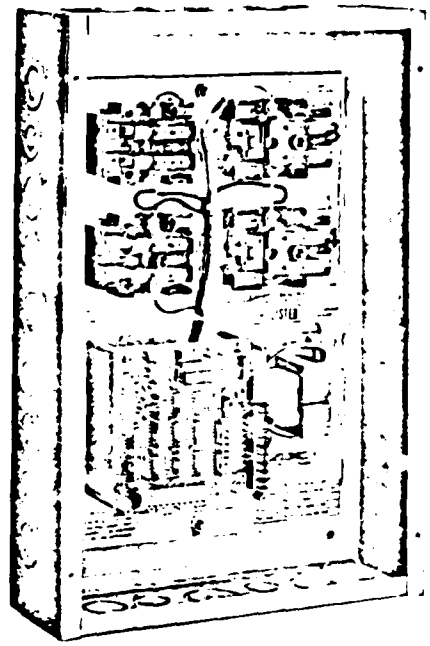
Standard Control Points	
Model 8	4 relays/8 control points
Model 12	6 relays/12 control points
Model 16	8 relays/16 control points
Enclosure Size (dependent upon relay configuration)	
Model 8	12" x 12" x 4" or 12" x 18" x 4"
Model 12	12" x 18" x 4"
Model 16	12" x 24" x 4"
Enclosure Type	Indoor Surface NEMA 1 Optional flush cover Outdoor rain tight NEMA 3
Relays	Normally closed Double pole-single throw 24V D C

ELECTRICAL

Power Required	115 volts ± 10% 60 hz 15 watts maximum
Relay Contacts	Max. 30 amp branch circuits
Circuitry	All solid state CMOS Logic
Shedding Sequence	Priority or rotate/priority (field selectable)
Environment	Operating Temperatures -40°F to 150°F
Input Measurement	Single Phase, 240V, 60Hz
Compressor Protection	5 minute delay (field selectable)
Warranty	3 year limited

FEATURES AND BENEFITS

- Compatible with all types of electric heating and cooling systems
- Remembers Set Point even after power outage
- Removable component sub assembly for easy enclosure mounting.
- Industrial quality relays assure long term reliability.
- Compatible with all utility control systems and load management systems



CURRENT TRANSFORMERS

MECHANICAL

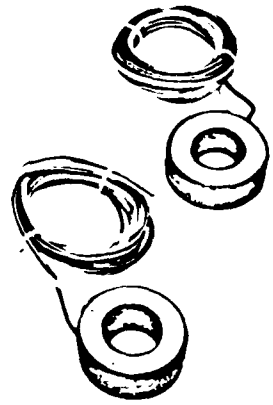
Each application	Two required
Type	Ring
Dimensions	
Type A	Standard - 7/8" I D x 2 1/4" O D (up to 250 MCM)
Type B	Large - 1 1/8" I D x 2 3/8" O D (up to 500 MCM)
Type C	Ex-Large - 3" I D x 4 1/2" O D

ELECTRICAL

Ratios	Two available. Standard and double ratio
Measurement Range	UL approved 200 amps (standard) or 400 amps (double ratio)
Accuracy	± 1%

FEATURES AND BENEFITS

- Current Transformer wiring may be configured to readily adapt control unit to multiple service entrances or multiple circuit breaker panels



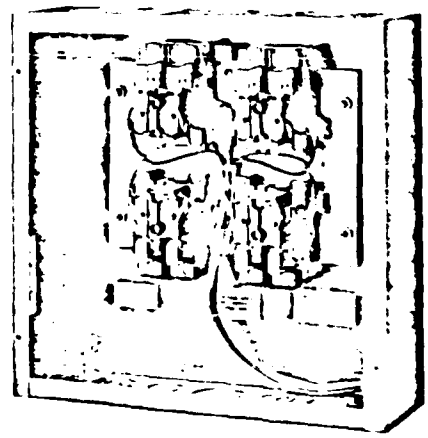
REMOTE RELAY UNITS

MECHANICAL

Purpose	To control loads at remote locations
Enclosure size	12" x 12" x 4" Surface NEMA 1
Relays	Four normally closed double pole single throw 24V D C
Relay Contacts	Max. 30 amp branch circuits
Power	Supplied by Control Unit (Class 2)
Interconnections to Control Unit	Up to 100 feet 5 conductor 18 guage wire

FEATURES AND BENEFITS

- Allows loads to be controlled at remote locations



CONTROL CABLE (not shown)

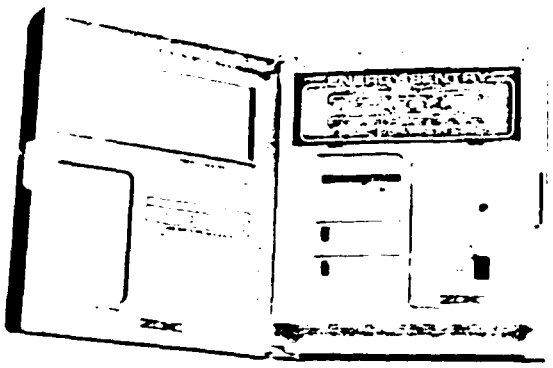
MECHANICAL

Number of Conductors	15
Wire Size	2 Conductors, 16 AWG Stranded 13 Conductors, 22 AWG, Solid
Insulation	Each wire .010 PVC, Jacket .030 PVC
UL Style	2464, 300V

FEATURES AND BENEFITS

- Allows standardized color coding for control panel – control unit interconnections

CONTROL PANELS

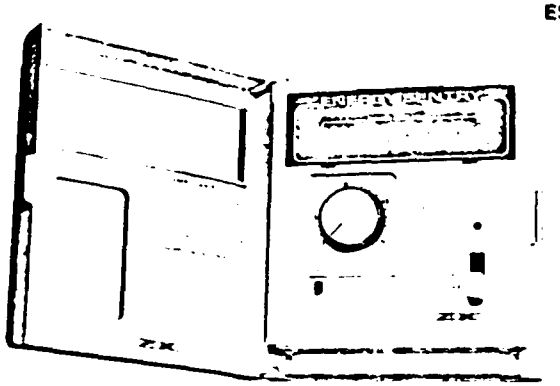


ALPHA SERIES—LED BAR GRAPH DISPLAY

Dimensions	6 3/8" h x 5 5/8" w x 1 3/4" d
Mounting	Surface (Mounting hardware supplied)
Electrical Connections	11 Control wires (4 relays) 15 Control wires (8 relays)
Maximum distance from control panel to control unit	100' with available cable
Power	Supplied by control unit (Class 2)
Status Lights	One per control relay
Demand Setting Range	3 to 30 KW (standard) 6 to 60 KW (with double ratio CT's)
Displayed Demand Range	0.5 to 30 KW (standard) 1.0 to 60 KW (with double ratio CT's)
Over-limit Indicator	Visual and audible
Display	
Set Point	LED point highlighted.
Average Demand	LED moving bar graph
Instantaneous Demand	LED moving bar graph
Set Point Indicator	Manually adjustable linear potentiometer behind decorative cover
Audible Tone	Variable switched (loud, soft, off)
Test Button	Verifies audible over-limit function

FEATURES AND BENEFITS

- Status lights indicate when loads are being managed
- Unique display eases user understanding of household power demand
- Easy Set Point adjustment in ½ KW increments up to 10 KW (2 KW increments above 10 KW)
- Hinged decorative cover protects against accidental changes in Set Point
- Convenient surface mounting

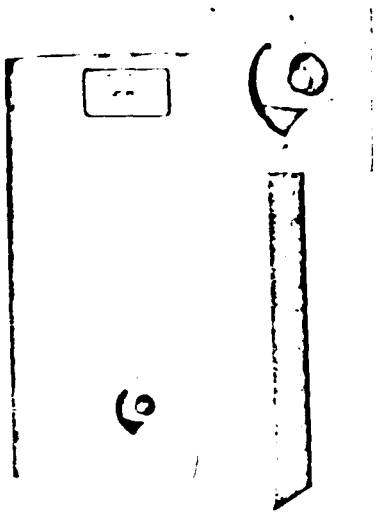


ES SERIES—STATUS LIGHT DISPLAY

Dimensions	6 3/8" h x 5 5/8" w x 1 3/4" d
Mounting	Surface (mounting hardware supplied)
Electrical Connections	11 Control wires (4 relays) 15 Control wires (8 relays)
Maximum distance from control panel to control unit	100' with available cable
Power	Supplied by control unit (Class 2)
Status Lights	One per control relay
Demand Setting Range	2 to 30 KW (standard) 4 to 60 KW (with double ratio CT's)
Over-limit Indicator	Visual and Audible
Set Point Indicator	Manual adjustment (behind decorative cover)
Audible Tone	Variable switched (loud, soft, off)
Test Button	Verifies audible over-limit function

FEATURES AND BENEFITS

- Status lights indicate when loads are being managed
- Simple display provides necessary user information
- Easy Set Point Adjustment in 1 KW increments
- Hinged decorative cover protects against accidental changes in Set Point
- Convenient surface mounting



SC SERIES—SELF CONTAINED, NO DISPLAY

Mounting	Internally contained in control unit
Power	Internal
Status Light	One
Demand Setting Range	2 to 25 KW
Over-limit Indicator	Audible (switched on/off) Remote Buzzer (Optional)
Other specifications	See control unit

FEATURES AND BENEFITS

- Concealed demand setting (behind [illegible] cover for rental property or utility applications)
- Set Point adjustable in 1 KW increments
- Lowest installed cost

REMOTE BUZZER PANEL (OPTION, NOT SHOWN)

Dimensions	2 3/4" w x 4 1/2" h Standard switch plate size
Mounting	Flush standard single gang J box (not supplied by ZOC)
Electrical	3 control wires (Class 2) (18 AWG, 100' maximum) Green LED pilot indicator Red LED over-limit indicator Audible (switched on/off)

FEATURES AND BENEFITS

- For use with Series 1 Self contained Control Unit
- Allows remote warning feature for over-limit condition
- Pilot light indicates operating

SYSTEM OVERVIEW

Energy Sentry Systems are suitable for use in all electric homes, apartments, condominiums, and small commercial buildings. Energy Sentry models are fully compatable with all types of electric heating and cooling systems including: Heat pump, baseboard, air conditioners, electric furnaces, boilers, and all radiant heat.

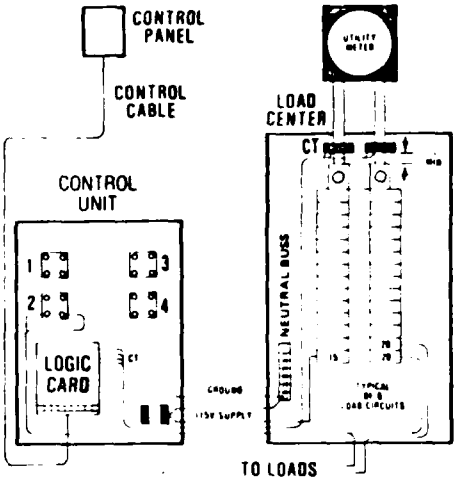
Each Energy Sentry System has been designed to automatically manage peak kilowatt demand. It constantly measures total power consumption and maintains a predetermined demand level by temporarily defering certain loads. An Energy Sentry System consists of a control unit, a control panel and a set of current transformers.

LOAD CONTROL SEQUENCE

The Energy Sentry sheds the least critical load first when it senses that the average total power consumption is about to exceed the demand set point. As necessary, additional loads are sequentially shed to prevent the metered demand from exceeding the demand limit set point. The last load to be shed will be restored first, the first load to be shed will be restored last.

The total power consumption is continuously averaged over the metering period. Since the controller sheds loads only when the average demand reaches the set point, it is possible to operate loads that are greater than the demand setting during a portion of the metering period.

When operating in the Heat Balancer mode, the controller rotates the first two relays every three minutes to avoid prolonged shed periods of loads on the first off relay. This operation can be selected by jumper option in the control unit.



UL LISTED

ORDERING INFORMATION

1 Specify Control Panel (Alpha, ES, SC).
2 Specify Control Unit Model (4, 6, 8, 16).
3 Specify Enclosure Type (I-Indoor, R-Raintight)
4 Specify Non-Standard Options

EXAMPLE:

Control Panel	Control Unit	Enclosure Type	Options
Alpha	8	I	Specify

STANDARD MODEL CHART

Model	Control Circuits	Relays	Standard Current Transformers	Enclosure Dimensions	Shipping Weight
Alpha 8I	8	4 DPST	Type A	12" x 18" x 4"	23
Alpha 16I	16	8 DPST	Type A	12" x 24" x 4"	29
ES 8I	8	4 DPST	Type A	12" x 18" x 4"	23
ES 16I	16	8 DPST	Type A	12" x 24" x 4"	29
SC 4I	4	2 DPST	Type A	12" x 12" x 4"	18
SC 6I	6	3 DPST	Type A	12" x 12" x 4"	19
SC 8I	8	4 DPST	Type A	12" x 18" x 4"	20

Contact factory for order information on non-standard models.

OPTIONS

- Raintight enclosure, specify (R)
- Non-standard current transformers, specify (B), (C), (2x)
- Remote relay units, specify (RM8)
- Remote buzzer panel, specify (RBP)
- Flush cover for flush mounting of control unit, specify (F)
- Control cable available lengths: 35', 60', 100', 250'

Warranty: 3-year limited -- see Owners' Manual for details.

FOR FURTHER INFORMATION CONTACT

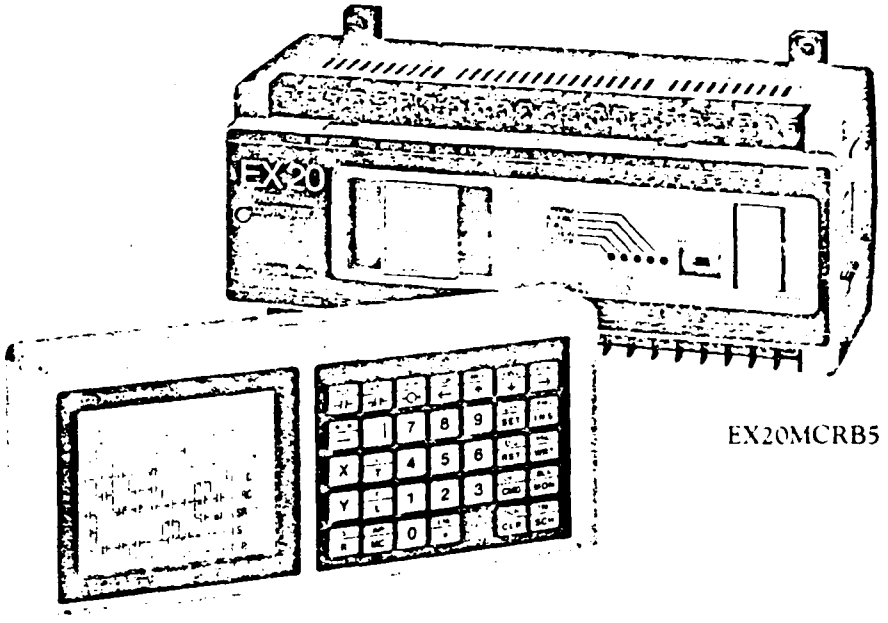
MANUFACTURED BY **SYNERGETICS INTERNATIONAL, INC.**

5665 ODELL PLACE BOULDER [illegible] 80301-3020

2R5 5K

TOSHIBA HOUSTON

EX20/40/40H SERIES PROGRAMMABLE CONTROLLER



EX20MCRB5

EX2040PRG

Controlling your power is easier than ever before with TOSHIBA/HOUSTON'S EX 20/40/40H series of Programmable Controllers. This programmable controller is especially suited for small scale control systems with 20 to 120 points of I/O.

- LCD Programmer enters programs in ladder diagram form.
- Status of several elements can be monitored on the programmer during execution.
- Jump, edge trigger, step sequence and flip flop instructions available along with timer, counter and master control.
- Program storage is by battery backup RAM or PROM MODULE.
- Expansion units can be connected to increase the number of I/O points (up to 120 points).
- Compact, light weight unit can be mounted with four screws, or on DIN rail.

TOSHIBA/HOUSTON
INTERNATIONAL CORPORATION 13131 WEST LITTLE YORK HOUSTON, TEXAS 77041 1-800-231-1412

TOSHIBA/HOUSTON
INTERNATIONAL CORPORATION

EX20/40/40H SERIES FUNCTIONAL SPECIFICATIONS

Main unit specifications EX20/40/40H

ITEM		EX20	EX40	EX40H
PROCESSING	EXECUTION SYSTEM	STORED PROGRAM, CYCLIC SCAN SYSTEM		
		INTERPRETER (SOFTWARE)		BIT PROCESSOR
	EXECUTION TIME (AVE.)	60μs/step	60μs/step	3μs/step
MEMORY	TYPE	CMOS RAM (BATTERY BACK-UP)/EPROM, E²PROM		
	SIZE	510 steps	1022 steps	1022 steps
INPUT/ OUTPUT	MINIMUM	12 INPUT + 8 OUTPUT	24 INPUT + 16 OUTPUT	24 INPUT + 16 OUTPUT
	MAXIMUM	24 INPUT + 16 OUTPUT	48 INPUT + 32 OUTPUT	72 INPUT + 48 OUTPUT
INSTRUCTION	CONTACT	⊣⊢, ⊣/⊢, ⊣↑⊢, ⊣↓⊢	⊣⊢, ⊣/⊢, ⊣↑⊢, ⊣↓⊢, ⊣↑↓⊢, ⊣↓↑⊢	
	OUTPUT COIL	─( )─		
	STEP SEQUENCE	N/A	─[ ]─, ⊢	
	TIMER	─(T)─ : 8(0.1 ~ 999.9s)	─(T)─ : 16(0.1 ~ 999.9s)	─(T)─ : 64(0.1 ~ 999.9s)
	COUNTER	─(C)─ : 8(1 ~ 9999)	─(C)─ : 16(1 ~ 9999)	─(C)─ : 64(1 ~ 9999)
	INTERNAL OUTPUT COIL	64 points	128 points	128 points
	LATCHED COIL	64 points	128 points	128 points
	FUNCTION	MASTER CONTROL	MASTER CONTROL, JUMP, FLIP-FLOP, SHIFT REGISTER, STEP SEQUENCER	
	OTHERS	END	END	END
SELF DIAGNOSIS		POWER, RUN, ERROR, ALARM, (PROM)		

Input specification

Description	Type of Input		
	Dry Contact	120VAC	24VDC
Rated Voltage	N/A	85-132VAC	20.4-26.4VDC
Input Current	10mA	10mA	10mA
"On" Delay	7.5ms	15ms	7.5ms
"Off" Delay	15ms	15ms	15ms
"On" Voltage	Junction Close	75V	16V
"Off" Voltage	Junction Open	25V	5V
Withstand Voltage	1500VAC - 1 minute		

Output specifications

Type	Relay output	Triac output	Transistor output
Rated voltage	115/230VAC, 24VDC	100-120VAC	24VDC
Rated current	2A	1A	1A
Maximum surge current	6A, 100ms	30A, 30ms	10A, 20ms
Saturation voltage	—	2V (maximum)	2V (maximum)
On delay	15ms	0.1ms	0.3ms
Off delay	10ms	10ms	10ms
Withstand voltage	1500VAC, 1 minute		

TOSHIBA/HOUSTON
INTERNATIONAL CORPORATION 13131 WEST LITTLE YORK, HOUSTON, TEXAS 77041 1-800-231-1412

EX20/40/40H SERIES

PROGRAMMABLE CONTROLLERS

BASIC UNIT 115/230V AC POWER SUPPLY **

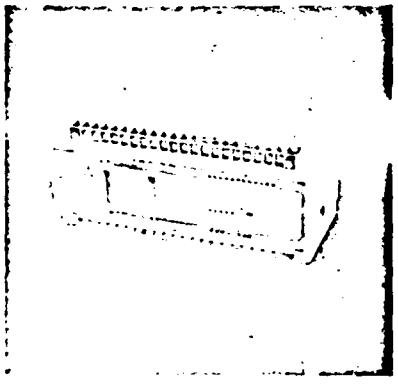
Type	I/O*	Input	Output	Order No	List Price
EX20	12/8	Dry Contact	Relay	EX20 MCRB5	$ 490 00
		Dry Contact	120V AC Triac	EX20 MCAB5	$ 614 00
		Dry Contact	24V DC Transistor	EX20 MCDB5	$ 546 00
		120V AC	Relay	EX20 MARB5	$ 580 00
		120V AC	120V AC Triac	EX20 MAAB5	$ 718 00
		24V DC	Relay	EX20 MDRB5	$ 495 00
		24V DC	24V DC Transistor	EX20 MDDB5	$ 550 00
EX40	24/16	Dry Contact	Relay	EX40 MCRB5	$ 760 00
		Dry Contact	120V AC Triac	EX40 MCAB5	$1024 00
		Dry Contact	24V DC Transistor	EX40 MCDB5	$ 862 00
		120V AC	Relay	EX40 MARB5	$ 854 00
		120V AC	120V AC Triac	EX40 MAAB5	$1084 00
		24V DC	Relay	EX40 MDRB5	$ 734 00
		24V DC	24V DC Transistor	EX40 MDDB5	$ 817 00
EX40H	24/16	Dry Contact	Relay	EX40H MCRB5	$1048 00
		Dry Contact	120V AC Triac	EX40H MCAB5	$1306 00
		Dry Contact	24V DC Transistor	EX40H MCDB5	$1180 00
		120V AC	Relay	EX40H MARB5	$1120 00
		120V AC	120V AC Triac	EX40H MAAB5	$1340 00
		24V DC	Relay	EX40H MDRB5	$ 980 00
		24V DC	24V DC Transistor	EX40H -MDDB5	$1088 00

NOTE For 2K RAM Models specify EX40H-MCRC5, LDC Programmer EX20D40PRG ***, and Prom EX2040RM64 (if PROM is required).

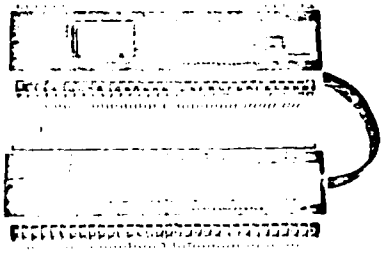
BASIC UNIT 24V DC POWER SUPPLY **

Type	I/O	Input	Output	Model No.	List Price
EX20	12 8	Dry Contact	Relay	EX20-MCRB6	$540 00
			24V DC Transistor	EX20-MCDB6	$591 00
EX40	24 16	Dry Contact	Relay	EX40-MCRB6	$780 00
			24V DC Transistor	EX40-MCDB6	$840 00
EX40H	24/16	Dry Contact	Relay	EX40H-MCRB6	$1 060 00
			24V DC Transistor	EX40H-MCDB6	$1 280 00

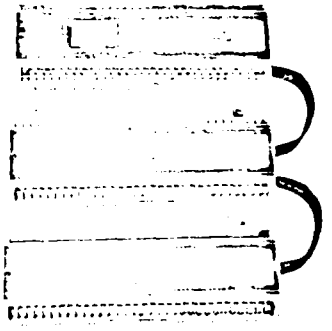
NOTES: *See The User's Manual for allowable I/O Configurations
**All units have PROM WRITER and EEPROM ERASE FUNCTION
***Contact Marketing



EX20MCRB5



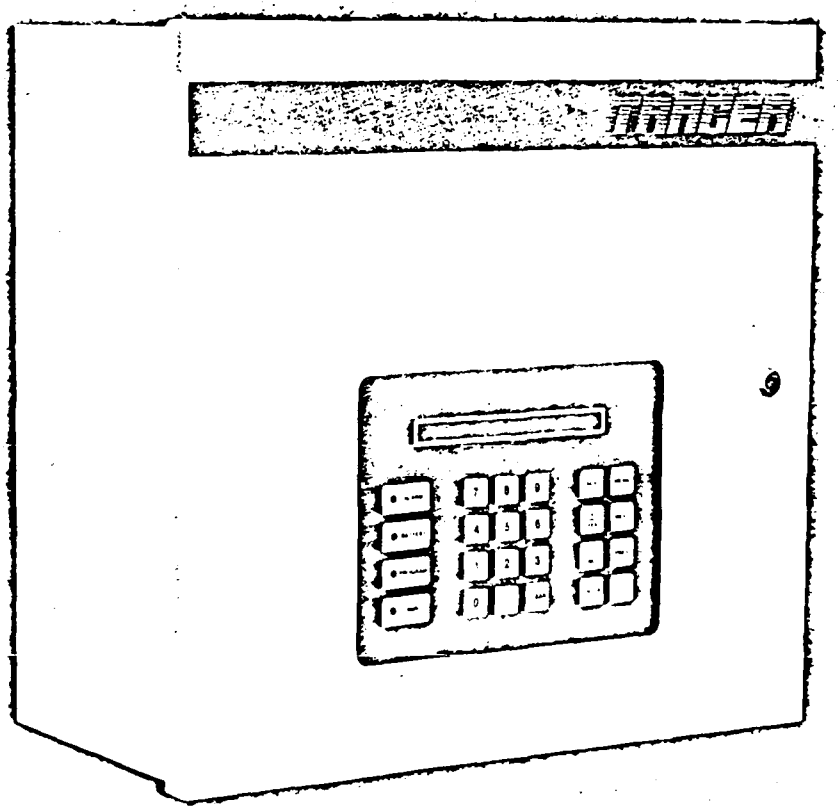
EX40MCAB5



EX40HMCRB6

TRANE COMPANY

Computerized HVAC system control



Saving money by saving energy

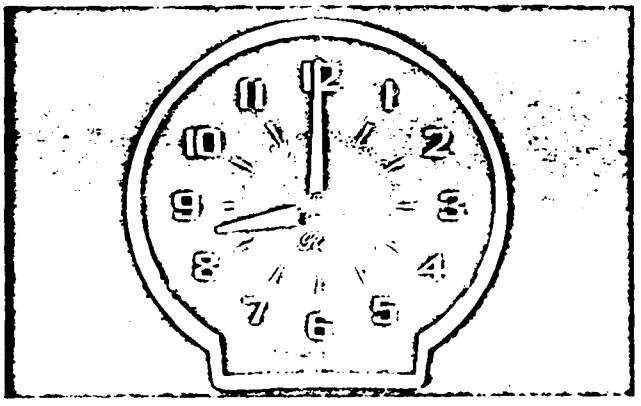
Introducing Tracer™, the latest addition to the Trane family of HVAC system controls. This microprocessor-based system can save enough energy to pay for itself in as little as two years.

Tracer works by controlling your building's biggest energy consumer, the heating and air conditioning equipment, for maximum savings yet comfortable operation.

Even better, the Tracer computerized control panel is brought to you by Trane, the same people who design and build HVAC equipment. It only makes sense -- the more you know about HVAC, the better you'll be at controlling it.

Look at the ways Tracer computerized control can save you money.

Scheduling



Running HVAC equipment when not needed is a costly energy drain. Such times include lunch hours, evenings and holidays. Although shutting units off can be done manually, it's time-consuming and easily overlooked. But by using a scheduling program, the Tracer™ control panel will promptly shut down HVAC units at preset times.

The Tracer control panel's scheduling program provides four start/stop times for each load on an eight-day cycle. It also automatically accounts for leap year, holidays and daylight savings time.

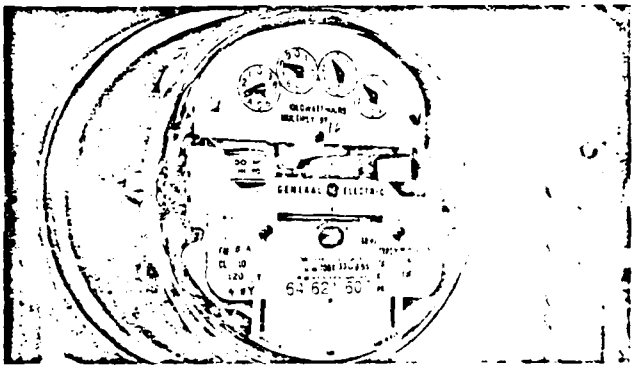
Duty cycling

Duty cycling turns HVAC equipment on and off during predetermined periods to reduce operating time and increase energy savings. The flexible Tracer system allows eight cycle patterns for each load. And to help assure equipment safety, Tracer provides minimum on and off protection timers for each piece of equipment.

Temperature compensated control

In order to ensure maximum occupant comfort, Tracer computerized control provides equipment cycling with automatic temperature override. That is, cycling will be reduced or stopped depending on whether room temperatures fall outside preset comfort levels. So it eliminates the guesswork of selecting the proper cycling strategies.

Demand limiting



Since demand charges typically account for as much as 50 percent of your energy bill, this feature can save you significant utility charges over a short time. To limit costly demand charges, Tracer computerized control gives you a predictive demand program that anticipates building electrical demand peaks. When the Tracer control panel senses a peak is about to occur, it simply turns off selected loads on a prioritized basis until the peak subsides, reducing your overall energy bill.

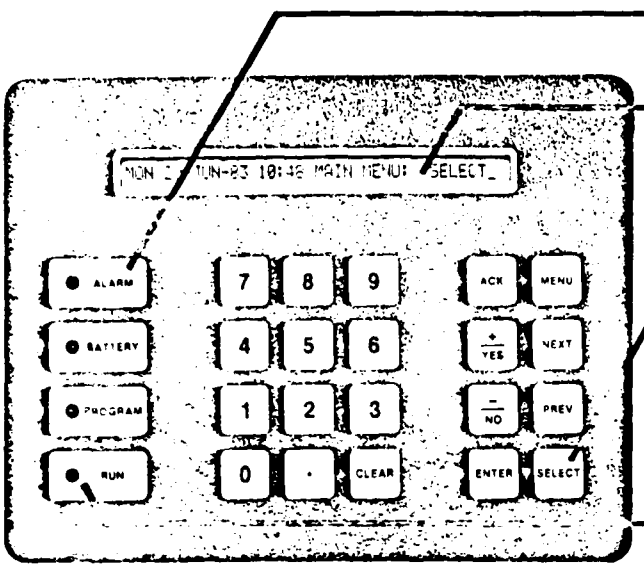
Optimum start/stop

HVAC equipment can waste energy by being scheduled to start and stop based on "worst case" conditions. As a result, units can begin operation too early and run too long. Tracer computerized control, however, monitors indoor and outside temperatures and determines the most efficient start and stop times without sacrificing comfort. Tracer optimum start/stop also allows independent control of each zone.

Night setback

Tracer night setback saves energy by automatically converting to a nighttime temperature setting. This set point overrides the daytime setting for every load. Units operate to maintain the nighttime setting until morning warm up or cool down. Tracer night setback also allows independent control of each zone.

Software that speaks your language



Advanced alarm system tells an operator when a problem occurred.

The Tracer self-prompting display with menu formatting in English easily walks operators through system programming.

The easy-to-use Tracer keyboard leads operators step-by-step through system programs, yet features the capability to by-pass programs and more quickly access specific data.

Indicator lights tell operators whether programs are running properly or if processes are hung up or halted.

Not only is *Trane dedicated to giving you the best energy control* programs, we're committed to making Tracer™ computerized control easy to use.

Proof is the Tracer control panel's self-prompting display with menu formatting in English. It walks operators step-by-step through system programs. And as users become more experienced, this advanced system lets them bypass menus to more quickly access specific data.

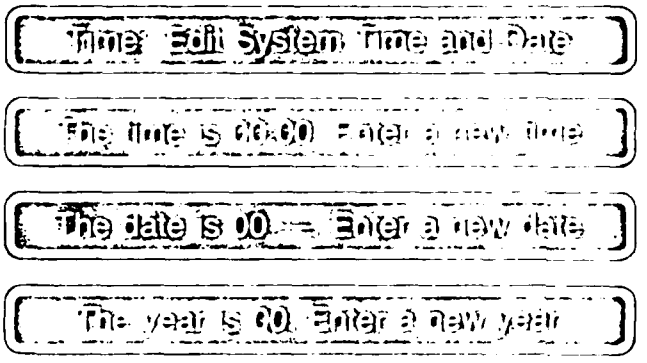
Tracer software is organized into user-friendly menu formats. Some example menu listings include:

- Building Status — tells users the status of each load such as what is on or off, what energy management strategy is applied, or what the temperature is.
- Reports — prints program reports on CRT or printer.
- Schedule, Duty Cycle and Demand Limit — these menus provide ready access to parameters needed for each strategy in addition to editing of the information.

To access menus, users simply press 'MENU' then 'NEXT'. Once landing on the right menu, operators press 'SELECT'. From here, the 'NEXT' and 'SELECT' keys lead users to the proper function within the menu. The 'PREVIOUS' key, meanwhile, allows operators to back up in case they passed their desired location or need to access previous menus.

Later, as users learn where specific functions are located, they need only press the number designating how many steps away the function is, followed by 'NEXT'. For instance, '6 NEXT' would instantly take users to the sixth menu. The 'PREVIOUS' key works the same way.

Look how easily the Tracer control panel leads operators through system programming.



Communication package tailored for effective human interface

Depending on the user's preference, the Tracer control panel can be connected to a CRT, printer and/or cassette tape player. And it features capacity for remote communication via telephone.

Both the CRT and printer offer remote capabilities for input and output. Only a printer provides hard copy reports for storage retrieval. Examples include energy reports as well as data trend, building status and alarm summary. A cassette player, meanwhile, acts as a data storage computer memory backup system.

After-hours flexibility

Tracer's normal scheduled program can be overridden via a remote-timed override switch. This allows occupants using the building during after-hour or setback times to simply turn equipment or lights on or off with the flip of a switch. More importantly, the Tracer control panel doesn't forget. After a specific time it will automatically turn the equipment or lights back to the normal mode.

An alarm with problem-solving feedback

The Tracer control panel's advanced alarm system tells an operator when and where a problem occurred. This detailed summary eliminates the need to look up error messages. Problems can be easily corrected — without paging through software codes.

If desired, the Tracer alarm can be wired to a warning horn and/or indicated on a remote CRT or printer. The alarms are determined by the operator — you decide what parameters to monitor.

Trouble-shooting made easy

Smart Tracer self-diagnostic capabilities quickly tell operators where a problem is. When the panel is first turned on, system cards are immediately checked for healthy program memory and linkages — RAM and ROM. Indicator lights flash if cards check out. No light means the card needs replacing.

During operation self-diagnostics continue. Panel lights for 'ALARM', 'PROGRAM' and 'RUN' indicate operation is fine via flashing. A constant light, on the other hand, means the process is hung up while no light means the process is halted. If the latter two occur, the operator simply turns off the unit, opens the panel then turns the unit on to check system cards.

Optional Boolean Processing customizes HVAC control

Boolean Processing overrides normal program functions and adapts them to unanticipated circumstances.

For instance, let's say an operator wanted to control parking lot lights to minimize energy consumption yet provide security. Normally the building is unoccupied after 8 pm and the lights are turned off. However, lights should remain on if people are in the building. Using Boolean Processing, the parking lot lights can be controlled by monitoring two separate conditions — time and equipment override switches. Therefore, if someone is in the building after 8 pm, the parking lot lights will remain on.

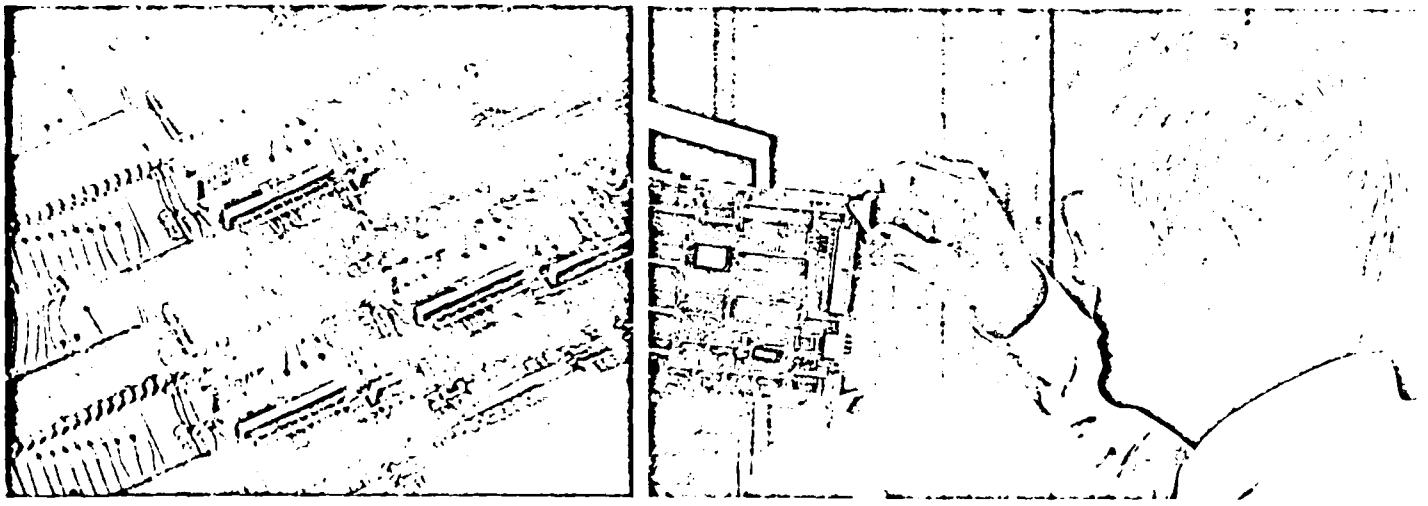
Software and hardware you can depend on

The Tracer control panel arrives at your building completely factory checked — from components to subassembly configuration to full run test. This thorough check helps ensure smooth installation and more dependable operation. In addition, the Tracer control panel features battery backup to keep programs intact in case of power loss for up to 48 hours.

Flexibility to buy for today and add for tomorrow

The flexible Tracer system lets you buy what you need, rather than make you purchase capacity you can't use. The arrangement is simple. Control points are purchased in increments of 0, 8 or 16 while analog and binary input points are purchased in allotments of 0, 4, 8, 12 or 16 — just so the total of each is no more than 16.

This modular design approach lets you add capacity as you need it. Just order the necessary additional cards, insert into place and, in seconds, you've expanded your system's capabilities.



The Tracer control panel's flexible internal structure lets you easily replace and add system cards

TRIANGLE MICROSYSTEMS, INC.

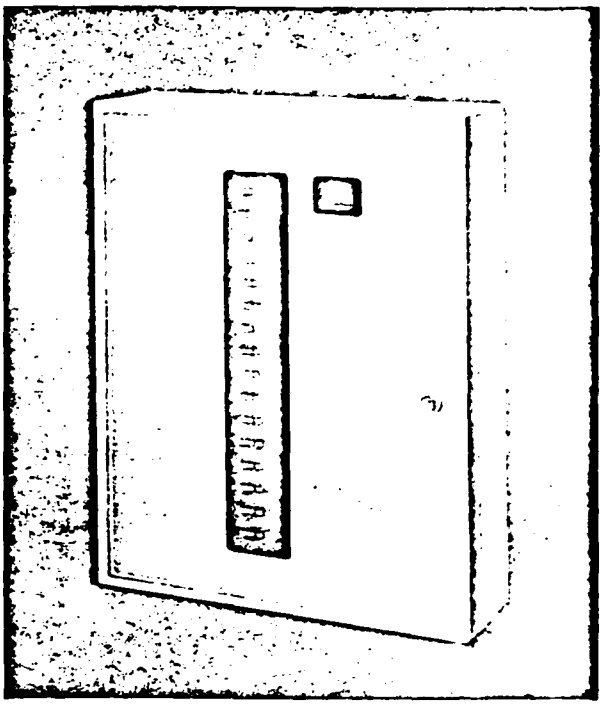
Facilitec by EMS

Facilitec Control's MP-128 is both a *menu-driven energy management system* and a *programmable controller for building automation.* Its uniqueness is that combination — the combining of all the accepted EMS strategies together with a proprietary controls programming language called *Versitec™*.

The prewritten EMS strategies, which come with the panel's 112K of ROM, have English prompts for the selection of operating parameters. *Versitec™* allows additional control programs, operating within the 128K of RAM provided, to implement virtually any control sequence the user can logically describe.

The MP-128 also comes with prewritten PID control firmware for *Direct Digital Control.*

Choosing the MP-128 avoids the choice between an EMS or a programmable controller — you get *both*, at a fair price for *either.*



SYSTEM FUNCTIONS:

A. Energy Management:
Pre-programmed algorithms resident in firmware.
- Demand monitoring with Load Shedding Control.
- Temperaure Compensated Duty Cycling.
- Night/Weekend Setback with Optimum Start/Stop.
- Enthalpy Control.
- Timed Events with built-in Real Time Clock.
- Virtually unlimited controls strategy with Versitec™, a powerful, built-in programming language.

B. Direct Digital Control:
Versitec™ set point commands and Slave Panel stand alone PID make Direct Digital Control affordable, and easy to implement.
- Transducer Control.
- Floating Point Control.

C. Facilities Management:
Assists the facilities manager in many otherwise time-consuming chores.
- Control of lighting, hot water, etc. with Timed Events.
- Monitoring of temperatures, pressures, door switches, smoke detectors, etc.
- Keep track of off hours energy use of tenants.

D. Maintenance Management:
Helps make *Preventive Maintenance* the rule, rather than the exception.
- Prints notification reports of scheduled maintenance.
- Reports impending equipment failures.
- Maintains equipment run-time and/or count totalization.

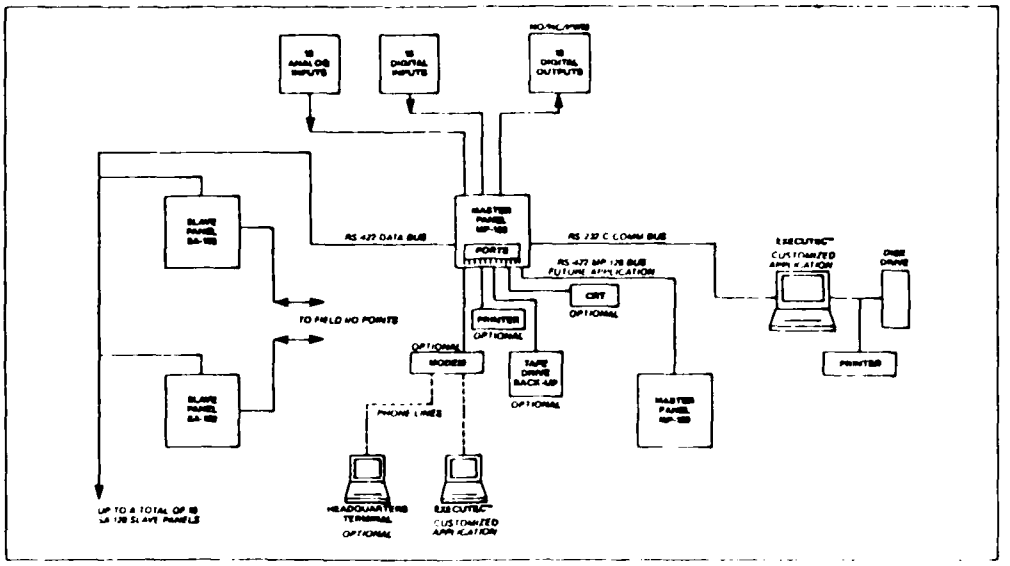
E. System Alarms:
Built-in screens, files, and reports.
- Provides single phase protection for critical 3 phase loads.
- Analog Inputs outside users specified limits and times.
- Relational alarms using digital input and digital output comparisons.
- Digital Input (switch closure) for unauthorized change of state.

F. System Reports:
Logs and Histories.
- Printed records of important information can be manually or automatically printed at user defined intervals.
- Ample RAM provided for user defined histories and logs using English prompts.
- Status reports in English by panel or by logically related groups.

G. Telephone Interface:
Standard Dial-Up Telephone Lines.
- Allows access from a remote location

FEATURES:

- **128K of RAM; 112K of ROM, providing all the widely accepted energy management strategies prewritten in firmware.**
- **Direct digital control of variable air handling systems, cold decks, mixed air, etc.**
- **DDC implemented through stand alone Slave Panels utilizing their own PID firmware.**
- **Versitec™ — An extremely powerful on-line user oriented programming language.**
- **Real time multitasking operating system.**
- **Power failure protection: Battery backed-up real time clock; Battery backed-up RAM; Auto-restore from bubble memory module.**



Facilitec™ MP/SA-128 Series functional block diagram.

MP-128 MASTER PANEL SPECIFICATIONS:

Operating Environment:
- Temperature: 0 C to 70 C
- Humidity: 95% RH, non-condensing

Communications:
- 2 — RS422 Ports, one for Master to Slave communication, one for future Master to Master communication
- 6 — RS232C Ports, four currently in use, two for future applications

I/O Configuration

16 Digital Inputs:
- Source voltage supplied
- Optically isolated

16 Digital Outputs:
- 300 MA at 12 volts supplied for each output
- Software Selectable:
  - Normally open
  - Normally closed
  - Alternator
  - Transducer/DDC with 100 millisecond resolution
  - Floating point/pulse width modulation at 100 millisecond resolution
  - Analog output by pulse width modulation

16 Analog Inputs:
- ± 2% of full scale
- 12 bit resolution
- 4-20 MA
- 8 ranges from 0-0.100 volts to 0-10 volts
- Current source provided to read resistance devices
- Voltage source provided to read IC Temperature Transducers

Demand Meter Input:
- One pulse initiator input for power demand monitoring

Overrides:
- Three position toggle switches for each load

Enclosure:
- Locking NEMA — 1 type, 18¾"x15"x4½"

Weight:
- 13 pounds

MP-128 POWER SUPPLIES:

Input Power:
- 115/230 VAC ± 10%, 47-440 HZ (UL, CSA, VDE)

Power Consumption:
- 230 Watts, max.

Overload Protection:
- Input fuse protected

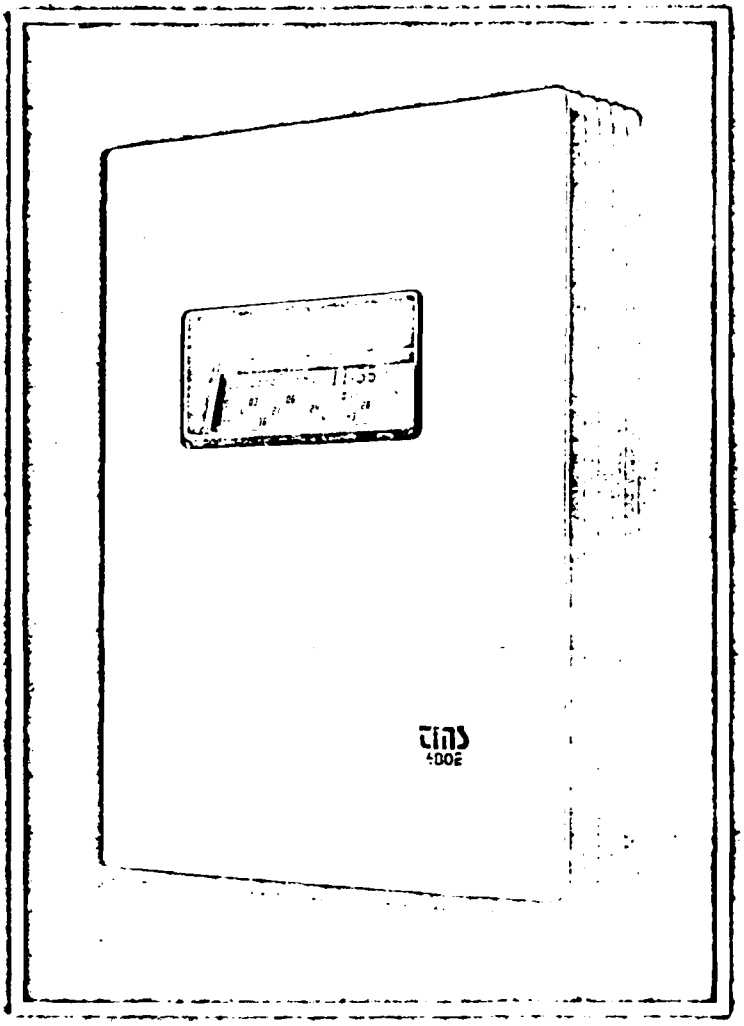
Operating Environment:
- Temperature: 0 C to 70 C
- Humidity: 95% RH, non-condensing

Enclosures:
- 18" X 15" X 4"; 12" X 10" X 4"

Weight:
- 30 pounds, 10 pounds

Facilitec CMS
8600 Jersey Court
Raleigh, NC 27612
919/782-2367

Presenting the TMS480E.



Excellence in concept and construction.

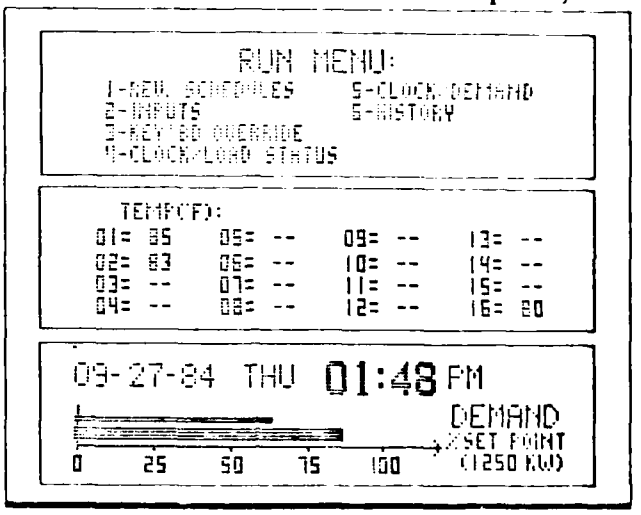
Take a closer look

The TMS480E is the full-function, stand-alone energy management system which has created a change in the standards by which other systems are measured.

Superiority Through Modularity

The TMS480E is modular in both concept and construction. As a result, you can tailor a system to suit your current needs, no more and no less, and retain the option of expanding your system should your needs change.

Load capacities can be increased in increments of four, to a maximum of sixteen loads in the Master Control Unit (MCU). Then, by combining up to four Remote Satellite Units (RSU), each adding another four to sixteen loads, the total system capacity expands to eighty loads.



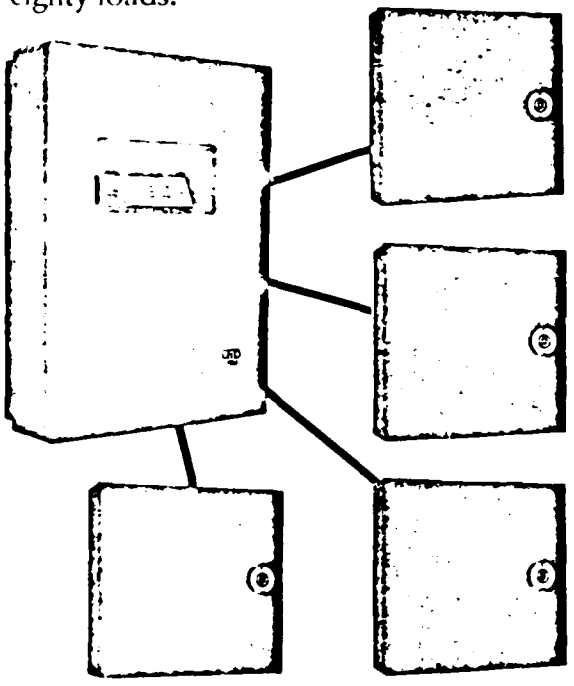
Modularity means the TMS480E is economical—not only to acquire but also to install, even in retrofit situations. A double twisted pair connecting the MCU to each RSU allows loads to be wired to the nearest RSU, which may be installed up to 1,000 feet away from the MCU. Though the TMS480E offers power line carrier as an option, in many installations it is unnecessary since the unique RSU provides tremendous installation flexibility.

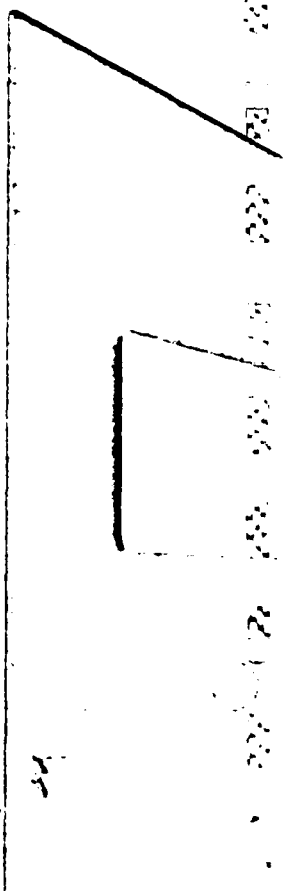
Abundant Inputs

A total of 80 analog inputs are included with a complete TMS480E system -16 in the MCU and 16 in each additional RSU. Plus, four digital inputs for demand control are built into every MCU. These inputs are not options. They're included and ready for you to use.

With the availability of many varied inputs, you can create a highly sophisticated program with a broad assortment of variables using the TMS480E's unique crisp full-dot matrix display.

The self-prompting screen makes programming a cinch. Even a novice operator can become an expert programmer in a few minutes.





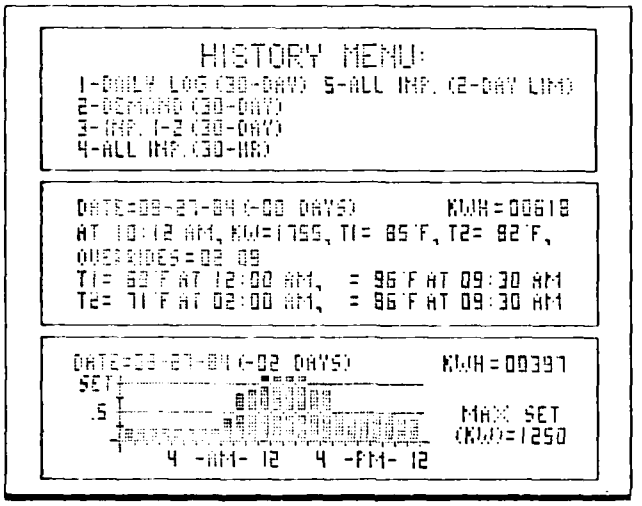
at the TMS480E.

Run vs. Program

The security of your system program is preserved by key-switch access, but the TMS480E still can provide vital information without the key, while in the run mode. Look closer.

You can determine the current status of all inputs and outputs, read real time status of KW demand, and exercise the option of overriding any load for a limited time through the keypad. In the run mode, you can still review all schedules in your system.

To alter or edit a schedule, switch the key to the program mode. Then, by simply advancing to the desired screen and positioning the cursor in the proper position, you can make a desired change in your program. It's that simple.



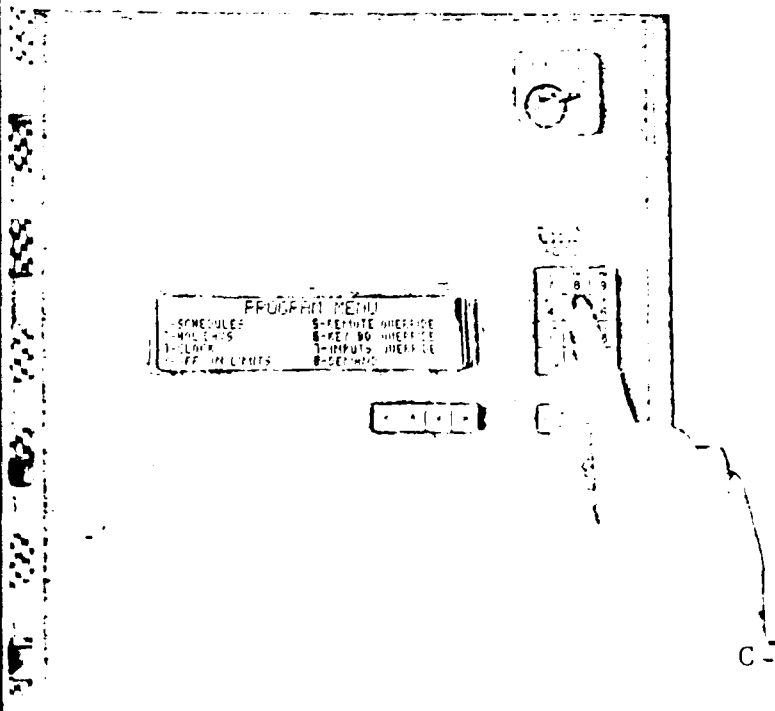
Vital Histories

The TMS480E provides a wealth of historical documentation which you need to fine tune your system. For the current day, you can read total KWH, peak demand (KW), temperatures (outside and inside), and the status of loads in override during the peak. In addition, you can determine current day high and low temperatures and their times, both inside and outside.

By continuing to press the "Next" key, the same information is displayed for each day for the last 30 days. As a result, you can easily make informed programming decisions.

Graphic histories are also displayed. You can access 24-hour demand histograms for the last 30 days, read hourly temperatures (both outside and inside) for the last 30 days, and obtain comprehensive temperature read-outs on each of 80 inputs for the last 30 hours. It's easy to identify the causes of energy consumption and judge the extent of required remedies.

These exclusive features are available only with the TMS480E.



Options and More.

Remote communications is available using an IBM PC computer system along with our powerful remote communications software package. One-way and two-way power line carrier are available, and an array of temperature sensors contribute to the versatility of the TMS480E.

When you take a closer look, it's easy to see why the TMS480E is rapidly becoming the standard by which other energy management systems are compared.

Triangle MicroSystems, Inc.
8600 Jersey Court
Raleigh, North Carolina 27612
Phone 800 334 5548 or
919/782-2367

The easy EMS.

Programming is simple using the menu control and the blinking cursor which prompts the user to enter error-free programs. These functions can make the novice operator into an expert in minutes.

```
PROGRAM MENU:
1-SCHEDULES          5-REMOTE OVERRIDE
2-HOLIDAYS           6-KEYPAD OVERRIDE
3-CLOCK              7-INPUTS OVERRIDE
4-OFF-ON LIMITS      8-DEMAND
```

Once a security key is switched to the program mode, a menu appears. Simply press the number associated with the desired function. As shown, the user has a full variety of functions from schedules and holidays to demand limiting, along with an assortment of overrides.

By pressing Number 1 a new menu appears that allows the user selections which include a daily repeat schedule, a temperature initiated schedule, and optimum start and stop.

```
SCHEDULES MENU:
1-DAILY (REPEATS)    5-OPT. START (HEAT)
2-ONE TIME           6-OPT. START (COOL)
3-OVERRIDE           7-OPT. STOP
4-INPUT-INITIATED    8-ALARMS
```

```
LD=01     LD OFF=MON              08:30 AM
          LD ON =MON              05:30 PM
REPEAT DAY= 0   TUE  WED  THU  FRI  0
TOT. CYCLE (MIN)=30     OFF=25 HT 80°F
  SENS=% (01-15)=01     OFF=05 HT 70°F
```

The cursor prompts the user to enter correct data only. Entire weekly schedules with temperature compensated duty cycling can be entered in one step. By using the cursor control keys, editing is the easiest function of all.

The optimum start/stop programs use the cursor to prompt entries of start/ stop times needed to reach the target temperatures. This two-dimensional matrix can have either fixed times or can be totally self-learning.

```
LD=06   SENSOR=02     TEMP=65
IN: |OUT: 70°  80°  90°  100  110°
 70° |  025   035   055   030   120
 80° |  030   060   090   120   180
 90° |  060   090   120   180   255
```

```
LD=03          SCHEDULE TEMPS: REQUIRE:80°F
  SENSOR (01-16)=10              BELOW:00°F

TOT. CYCLE (MIN)=30     OFF=10 HT 00°F
  SENSOR (01-16)=00     OFF=00 HT 00°F
```

The input initiated schedule allows the user the ability to control loads based *on temperature rather than time or demand. This creates* many useful and innovative applications, including allowing the TMS480E to replace thermostat functions.

The TMS480E contains essential on/off limiting programs to prevent shortcycling of loads. For demand load shedding, maximum off times can also be specified.

```
LD=10          SET LIMITS (HH:MM):

          MINIMUM OFF=  :05
          MINIMUM ON =  :05
          MAXIMUM OFF= 1:00
```

```
LOAD SHED PRIORITY (1=FIRST OFF):
0- 50  51  52  53  54  55  56  57
1- 60  61  62  63  64  65  66  67
2- 70  71  72  73  74  75  76  77
3- 00  00  00  00  00  00  00  00
```

Demand load shedding is simple to program and extremely flexible in design strategy. With 64 loads capable of being shed, the user can program both a "first off-last on" and/or a rotational strategy to limit demand. Multiple demand set points may also be entered.

Specifications

Master Control Unit (MCU)

Size: 17" × 12.5" × 3½"
Weight: 20 lbs
4 to 16 relay outputs
16 analog/digital inputs
Power requirements: 115/230 VAC ±10%, 1.5A at 50/60 Hz
Temperature: 0°F to 100°F
Housing
0°F to 125°F non-operating
Humidity: 20% to 90% non-condensing
Inputs
Optical dry contact inputs
Analog: 0-5VDC, temperature sensor 2 standard 250°

Range: -10°F to +125°F standard
-40°F to +212°F optional
Relay outputs: SPDT dry contacts or SPST 24 VAC
4 A Resistive and 2A Inductive
Remote manual override
Local manual override

Remote Satellite Unit (RSU)

Size: 12"×7" × 12"×7" × 4½"
Weight: 20 lbs
4 to 16 relay outputs
16 analog/digital inputs
Power requirements: 115/230 VAC ±10%, 1.5A at 50/60 Hz
Up to 1000' distance between MCU and RSU

Miscellaneous:

All CMOS *integrated circuits*
Transient suppressors across all relay contacts
Battery back-up: 48 hour minimum
Input power line filter
Optical isolation for remote overrides and satellite communications
Electrostatic shielding of critical components

Programming capabilities include:

Time of day scheduling
One time scheduling
Temperature initiated scheduling
Temperature compensated duty cycling
365 day holiday programming 28 holidays
Minimum on/minimum off on/off limits
Override schedules
Keyboard manual override
Remote manual override
Touch tone telephone override
Temperature initiated override
Automatic daylight saving time capability
Fixed or self learning optimized start stop
Demand limiting load shedding
15 or 30 minute demand sliding window
4 demand set points
Auto Dial Alarm Notification

Triangle MicroSystems, Inc.
8600 Jersey Court
Raleigh, North Carolina 27612
Phone 800/334-5548 or 919/782-2367

END

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DTIC